UNITED STATES AIR FORCE
ELMENDORF AIR FORCE BASE, ALASKA

ENVIRONMENTAL RESTORATION PROGRAM

FIVE-YEAR REVIEW
Second Five-Year Review Report

Final Report

NOVEMBER 2003

ERRATA Sheet

After this document was signed by the Air Force, minor errors were identified by the agencies. This errata sheet serves to correct those minor errors.

- New Table 4-9. Table 4-9 in the Five-Year Review does not identify the correct cleanup levels at SD25. The new table below reflects the correct cleanup levels as referenced in the record of decision for Operable Unit 4.

Table 4-9

Cleanup Levels at OU4

Location	Contaminant of Concern	ROD-Established Cleanup Level	Source of Requirements
Groundwater (µg/L)			
FT23	1,1,1-Trichloroethane	200	MCL[1]
	1,1-Dichlororethene	7	MCL[1]
	1,2-Dichloroethane	6	MCL[1]
	Tetrachloroethene	6	MCL[1]
	Trichloroethene	6	MCL[1]
	1,2-Dichloroethene	70	MCL[1]
	Benzene	5	MCL[1]
SD25	Benzene	5	MCL[1]
	Ethylbenzene	700	MCL[1]
	Toluene	1,000	MCL[1]
SD24, SD26, SD27	Benzene	5	MCL[1]
SD28, SD29	Tetrachloroethene	5	MCL[1]
	Trichloroethene	5	MCL[1]
Soil (mg/kg)			
FT23	DRO	2,000	ACM[2]
	GRO	1,000	ACM[2]
SD25	DRO	2,000	ACM[2]
	GRO	1,000	ACM[2]
SS10	DRO	2,000	ACM[2]
	Jet Fuel	2,000	ACM[2]
	Xylene	100	ACM[2]
	GRO	1,000	ACM[2]

[1]40 CFR Part 131, and 18 ACC Chapter 70.010a and d, 70.015 through 70.0110, 18 AAC 80.070.
[2]ACM – Alaska Cleanup Matrix Level D, 18 AAC 78.315.
Note: There are no cleanup levels for soil at SD26, SD27, SD28, and SD29 because contaminant levels were below regulatory standards at the time of the ROD

- New Table 4-22. Table 4-22 in the Five-Year incorrectly described the land use controls at WP14. WP14 is not a landfill or disposal site and there are no "Restricted Use Area" land use controls. The only land use controls at WP14 pertain to groundwater restrictions. In addition, the land use controls for OU1 and SD15 have been clarified.

ERRATA Sheet

Table 4-22

Site-Specific Land Use Controls, Elmendorf AFB

OU (Site)	Land Use Control (LUC) Description	Expected Year of LUC Expiration
1	"Restricted Use Area" designated for recreational use and construction of unmanned facilities (such as parking lots, storage buildings, etc.). The construction of manned facilities (such as office buildings or residential structures) is strictly prohibited. Excavation affecting the integrity and function of the landfill caps, or impacting the shallow groundwater table is not allowed.	2033[1]
2 (ST41)	"Restricted Use Area" designated for recreational use of the parcel (such as cross-country skiing, etc.) and construction of unmanned facilities (such as parking lots, storage buildings, or taxiways). The construction of manned facilities (such as office buildings or residential structures) is strictly prohibited. As long as hazardous substances remain on this site at levels that preclude unrestricted use, groundwater development and the use of the groundwater at this site for any purpose including, but not limited to, drinking, irrigation, fire control, dust control or any other activity is prohibited.	2016
3	No site-specific LUCs are in effect at OU3.	
4	"Airfield Use Area" designated for aircraft O&M, which include active and inactive runways, taxiways, and parking aprons for aircraft. The establishment of residential development of the areas is strictly prohibited.	2006
5	No site-specific LUCs are in effect at OU5.	
6 (LF02)	"Restricted Use Area" designated for recreational use of the parcel (such as cross-country skiing, etc.) and construction of unmanned facilities (such as parking lots, storage buildings, or taxiways). The construction of manned facilities (such as office buildings or residential structures) is strictly prohibited. Drilling into the shallow aquifer is restricted by the Base Comprehensive Plan. As a former landfill, this designation will remain indefinitely.	Indefinite

ERRATA Sheet

Table 4-22 (Continued)

OU (Site)	Land Use Control (LUC) Description	Expected Year of LUC Expiration
6 (LF03)	"Restricted Use Area" designated for recreational use of the parcel (such as cross-country skiing, etc.) and construction of unmanned facilities (such as parking lots, storage buildings, or taxiways). The construction of any sort of manned facilities (such as office buildings or residential structures) is strictly prohibited. As a former landfill, this designation will remain indefinitely. This site is also permanently included in the "accident potential zone" which further restricts the construction of any above ground facilities at this location.	Indefinite
6 (LF04)	"Restricted Use Area" designated for recreational use of the parcel (such as cross-country skiing, etc.) and construction of unmanned facilities (such as parking lots, storage buildings, or taxiways). The construction of any sort of manned facilities (such as office buildings or residential structures) is strictly prohibited. As a former landfill, this designation will remain indefinitely. The use of contaminated groundwater throughout LF04 for any purpose including, but not limited to, drinking, irrigation, fire control, dust control or any other activity is prohibited. Drilling into the shallow aquifer is also restricted.	Indefinite
6 (SD15)	Land use controls restrict access to contaminated groundwater throughout the site. Installation of wells in the contaminated plume for residential, industrial, or agricultural use will be prohibited until cleanup levels have been achieved.	TBD[2]
6 (WP14)	Land use controls restrict access to contaminated groundwater throughout the site. Installation of wells in the contaminated plume for residential, industrial, or agricultural use will be prohibited until cleanup levels have been achieved.	2011
(SA100)	No site-specific LUCs are in effect at SA100.	

Notes:
[1] OU1 ROD states that land use controls will continue until groundwater clean up goals are reached. Currently at OU1 groundwater clean up goals have been reached at LF05, LF07, LF13 and OT56 and the land use controls at these sites within OU1 will expire once a closure document for these sites are signed. After LF05, LF07, LF13, and OT56 close document is signed, then land use controls will be in effect for LF59 only.

[2] The land use controls at SD15 will continue until groundwater clean up goals are reached. A groundwater model will be completed in FY05 and this model should provide an estimate on how long the land use controls will continue.

LEAD AGENCY ACCEPTANCE
SECOND FIVE-YEAR REVIEW
ELMENDORF AIR FORCE BASE

This signature sheet documents the United States Air Force acceptance of the second Five-Year Review for Elmendorf Air Force Base.

JAMES P. STURCH
Colonel, United States Air Force
Vice Commander

17 Dec 03
DATE

SUPPORT AGENCY ACCEPTANCE
SECOND FIVE-YEAR REVIEW
ELMENDORF AIR FORCE BASE

This signature sheet documents the United States Environmental Protection Agency acceptance of the second Five-Year Review for Elmendorf Air Force Base.

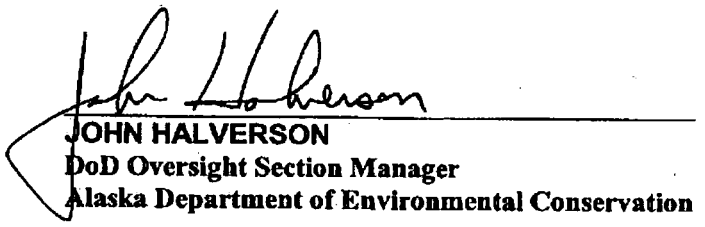
FOR

MICHAEL F. GEARHEARD, Director
Environmental Cleanup Office
Region X
U.S. Environmental Protection Agency

1/27/04
DATE

SUPPORT AGENCY ACCEPTANCE
SECOND FIVE-YEAR REVIEW
ELMENDORF AIR FORCE BASE

The State of Alaska Department of Environmental Conservation concurs with the second Five-Year Review for Elmendorf Air Force Base.



JOHN HALVERSON
DoD Oversight Section Manager
Alaska Department of Environmental Conservation

1/27/04
DATE

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ATTACHMENTS

ACRONYMS AND ABBREVIATIONS

µg/L	micrograms per liter
AAC	Alaska Administrative Code
ACM	Alaska Cleanup Matrix
ADEC	Alaska Department of Environmental Conservation
AFB	Air Force Base
AFCEE	Air Force Center for Environmental Excellence
ARAR	applicable or relevant and appropriate requirement
bgs	below ground surface
BTEX	benzene, toluene, ethylbenzene, and total xylenes
CEB	Community Environmental Board
CES	Civil Engineering Squadron
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
COC	contaminant of concern
COPC	contaminant of potential concern
DRO	diesel range organics
EE/CA	engineering evaluation/cost analysis
EOD	Explosive Ordnance Disposal
EPA	U.S. Environmental Protection Agency
FFA	Federal Facilities Agreement
FTA	fire training area
FY	fiscal year
GRO	gasoline range organics
HVE	high-vacuum extraction
HpCDD	heptachlorodibenzo-p-dioxin
HxCDD	hexachlorodibenzo-p-dioxin
IRA	Interim Remedial Action
LUC	land use control
MCL	maximum contaminant level
mg/kg	milligrams per kilogram
mg/kg/day	milligrams per kilogram per day
NA	not applicable
ND	non-detect (not detected)
NCP	National Contingency Plan
NFA	no further action
NPL	National Priorities List
O&M	operation and maintenance
OSWER	Office of Solid Waste and Emergency Response
OU	Operable Unit
PAH	polynuclear aromatic hydrocarbons
PCB	polychlorinated biphenyl
PeCDD	pentachlorodibenzo-p-dioxin
PeCDF	pentachlorodibenzofuran
POL	petroleum, oils, and lubricants
RAO	remedial action objective
RBC	risk-based concentrations

ACRONYMS AND ABBREVIATIONS (Continued)

RCRA	Resource Conservation and Recovery Act
RRO	residual range organics
RI/FS	Remedial Investigation/Feasibility Study
ROD	Record of Decision
SARA	Superfund Amendments and Reauthorization Act
SVE	soil vapor extraction
SWQC	surface water quality criteria
TAH	total aromatic hydrocarbon
TaqH	total aqueous hydrocarbon
TBC	to be considered
TCDD	tetrachlorodibenzo-p-dioxin
TCDF	tetrachlorodibenzofuran
TCE	trichloroethylene (trichloroethene)
TCLP	Toxicity Characteristic Leaching Procedure
TFH	Total Fuel Hydrocarbons
TVH	Total Volatile Hydrocarbons
USAF	U.S. Air Force
UST	underground storage tank
VOC	volatile organic compound
WRS	wetland remediation system

EXECUTIVE SUMMARY

The purpose of this five-year review is to evaluate the implementation and performance of the remedial actions that were selected in Record of Decision (ROD) for each Operable Unit (OU). The contaminant sources at Elmendorf Air Force Base (AFB), Alaska are grouped into six areas including OU1, OU2, OU4, OU5, OU6, and SA100. The remedies vary by site and have included contaminated soil and debris removal, institutional controls, monitored natural attenuation of contaminated groundwater, and operation and monitoring of several active remediation systems such as free-product recovery, high-vacuum extraction (HVE), constructed wetland, and in-situ bioventing. This is the second five-year review for Elmendorf AFB. The trigger for this review was the signing of the first five-year review report on November 4, 1998.

The Five-Year Review Summary Form on the following pages presents the issues that were identified during the review, associated recommendations and follow-up actions, and protectiveness statements for each area.

The assessment of this five-year review found that the remedies were constructed and in general, are operating and functioning as intended by decision documents. For the source areas within OU1, OU2, OU4, and OU6 that have not met groundwater cleanup levels, the remedies are expected to be protective of human health and the environment upon attainment of groundwater cleanup levels through natural attenuation. At some sites (i.e., OU2, OU4, OU5, OU6) it is expected to take longer to achieve these goals than predicted in the RODs. In addition, a treatability study that includes system optimization efforts is underway to address remaining soil contamination at OU6 and the remedy is expected to be protective upon completion. In the interim, exposure pathways that could result in unacceptable risks are being controlled (i.e., with land use controls).

The remedy at OU5 currently protects human health and the environment in the short-term because, at present, TCE has not exceeded cleanup levels at the point of compliance (i.e., Ship Creek). However, in order for the remedy to be protective in the long-term, Seeps 9, 10, and 11 must be captured and treated, and investigation into the nature and extent of the TCE plume feeding the seeps at OU5 must be continued and evaluated to ensure long-term protectiveness.

The remedy at SA100, immediate response and removal action, is complete and protective of human health and the environment. Confirmation samples show that no contamination above background levels/regulatory cleanup levels remains and SA100 is acceptable for unlimited use and unrestricted exposure.

FIVE-YEAR REVIEW SUMMARY FORM

SITE IDENTIFICATION		
Site name: Elmendorf Air Force Base		
EPA ID: AK8570028649		
Region: X	**State:** Alaska	**City/County:** Anchorage
SITE STATUS		
NPL Status: Currently on the Final NPL		
Remediation status: Operating		
Multiple OUs?: YES	**Construction completion date:** March 2010	
Has site been put into reuse? NO (some areas are being used)		
REVIEW STATUS		
Lead agency: U.S. Air Force		
Author/Organization: 3rd Civil Engineering Squadron, Environmental Restoration		
Review Period: December 2002 through August 2003		
Date(s) of site inspection: January—May, 2003		
Type of review: Post-SARA		
Review number: 2 (second)		
Triggering action: Previous Five-Year Review Report		
Triggering action date: November 4, 1998		
Due date (five years after triggering action date): November 4, 2003		

Issues (Refer to the next section/page for associated recommendations and follow-up actions):

1. Levels of benzene in the seep on the north side of ST41, and upgradient of the point of compliance, exceeded cleanup levels in 2002. Although it is expected that the point of compliance contaminant concentrations will be below Alaska surface water quality criteria as established in the OU2 ROD, the analytical suite doesn't include TAH and TAqH to ensure compliance with these criteria.
2. Additional contaminated seeps at OU5, not currently collected and treated by the remedy, were sampled and three seeps were found to have trichloroethene (TCE) levels above cleanup levels.
3. Although monitoring has shown that the remedies are reducing contaminants, it appears to be occurring at a slower rate than predicted by the RODs and/or models and cleanup levels may not be achieved within the timeframes specified in the RODs. This includes:
   - OU2: BTEX may not reach groundwater cleanup levels by 2016.
   - OU4: TCE concentrations in the East Plume; TCE, tetrachloroethane, and 1,2-dichloroethene in the fire training area Plume (FT23); and benzene in wells OU4W-04 and OU4W-06 may not reach groundwater cleanup levels by the target date of 2008. In addition, the bioventing system at FT23 was expanded in 2003 to address additional soil contamination discovered at this site. Therefore, soil cleanup levels in the new area may not be met by 2008.
   - OU5: TCE groundwater cleanup levels may not be met by 2026.
   - OU6: Monitoring trends indicate that COCs in groundwater at the WP14/LF04 South area may not meet cleanup levels by 2025; however, cleanup work as part of a State agreement at a nearby site is expected to improve the cleanup schedule. At SD15, benzene and TCE concentrations remain above groundwater cleanup levels and contaminant removal rates suggest that the high vacuum extraction (HVE) system is approaching design limitations and natural attenuation will be more heavily relied upon to reach groundwater cleanup levels and COCs may not reach cleanup levels within the timeframe (5 years of HVE operation) predicted in the OU6 ROD.
4. Possible migration of contaminants from soils having DRO, GRO, and BTEX concentrations exceeding ADEC ACM Level D cleanup criteria exists at two locations in relatively shallow soils above the perched aquifer at SD15. A treatability study is being implemented for the shallow soil locations to determine if HVE system modifications will effectively treat these areas.

FIVE-YEAR REVIEW SUMMARY FORM (Continued)

Recommendations and Follow-up Actions (Item #s refer to Issue #'s in previous section):

1. To ensure compliance with Alaska surface water quality criteria as established in the OU2 ROD, sample for TAH and TAqH.
2. To address the three newly identified TCE-contaminated seeps at OU5, the USAF will contract design of additional discharge structures to capture and divert the seeps to the WRS in 2003. Construction will occur in 2004. The WRS will be operated and monitored until cleanup levels are met.
3. For groundwater, conduct a thorough review of modeling results and evaluate the potential for natural attenuation to achieve cleanup levels in the timeframes specified in the RODs. Revise and/or recalibrate the models, if needed. Continue groundwater monitoring according to the guidelines of the Basewide Groundwater Monitoring Program until cleanup levels are met. For OU4, continue bioventing at the new site until soil cleanup levels are met.
4. Monitor effectiveness of the recently implemented treatability study (modifications to the HVE system at SD15) and verify effectiveness of treating shallow soils at the two areas of contamination.

In addition to the recommendations and follow-up actions presented above, several additional recommendations are suggested to optimize the remedy and/or minimize unnecessary costs. These include:

- In OU1, cleanup levels have been met at sites LF05, LF07, LF13 and OT56. Wells at these sites should be removed from the Basewide Groundwater Monitoring Program and the sites are recommended for closure.
- In OU4, close the bioventing system at SD25 because it has been documented that residential soil cleanup levels have been reached.
- Monitor for natural attenuation of groundwater at a reduced frequency as determined by the Decision Guide for Monitoring Well Sampling Frequency (Attachment C, Figure C-2). These include:
  - Discontinue monitoring for manganese at LF59 because manganese concentrations have been below the ROD-specified cleanup level for two consecutive sampling rounds in all wells.
  - Review and revise the frequency of sampling for some wells in OU4, OU5, and OU6 in accordance with the decision guide (USAF, 2002f). Several wells in OU4 have been shown to meet COC cleanup levels and warrant less frequent monitoring; benzene monitoring may be reduced at wells within OU5 that have historically been below cleanup levels; TCE monitoring may be reduced at several OU6 wells that have consistently been below cleanup levels; and some wells associated with unstable plumes in OU5 may require more frequent monitoring.
- Annual sediment sampling at ST37 in OU5 has been conducted annually since 1997 and none of the sediment samples have contained fuel constituents (i.e., TFH-diesel, BTEX, PAH) at concentrations above State regulatory cleanup levels. Sediment results collected to date are sufficient to demonstrate that significant levels of COCs are not accumulating in the sediment in the Wetland Cell or Beaver Pond; therefore, sediment monitoring at ST37 should be discontinued.
- A site closure report demonstrates applicable cleanup levels, acceptable for residential use, have been met and land use controls are not needed at SA100; therefore, USAF considers this site closed following this five-year review and it is not necessary to include SA100 in subsequent five-year reviews.

FIVE-YEAR REVIEW SUMMARY FORM (Continued)

Protectiveness Statements:

- The remedy at OU1 is expected to be protective of human health and the environment upon attainment of groundwater cleanup levels, through natural attenuation, at one remaining site (LF59). In the interim, exposure pathways that could result in unacceptable risks are being controlled.
- The remedy at OU2 is expected to be protective of human health and the environment upon attainment of groundwater cleanup levels, through natural attenuation, at ST41. In the interim, exposure pathways that could result in unacceptable risks are being controlled.
- The remedy at OU4 is expected to be protective of human health and the environment upon attainment of soil cleanup levels through bioventing at two remaining sites (FT23 and SS10) and attainment of groundwater cleanup levels through natural attenuation. In the interim, exposure pathways that could result in unacceptable risks are being controlled.
- The remedy at OU5 currently protects human health and the environment in the short-term because at present, TCE has not exceeded cleanup levels at the point of compliance (i.e., Ship Creek). However, in order for the remedy to be protective in the long-term, Seeps 9, 10, and 11 must be captured and treated, and the investigation into the nature and extent of the TCE plume feeding the seeps at OU5 must be continued and evaluated to ensure long-term protectiveness.
- For OU6 the following protectiveness statements apply:
  - The remedy at LF04 North/Beach is protects human health and the environment by annual removal of exposed landfill debris. In the interim, exposure pathways that could result in unacceptable risks are being controlled.
  - The remedies at LF04 South, WP14 and LF02 are expected to be protective of human health and the environment upon attainment of groundwater cleanup goals through natural attenuation and recovery of free product (at LF04 South and WP14). In the interim, exposure pathways that could result in unacceptable risks are being controlled.
  - At SD15, the remedy currently protects human health and the environment in the short-term because the HVE has significantly reduced contamination and LUCs are in place to eliminate known points of exposure. However, in order for the remedy to be protective in the long-term, methods to treat the remaining areas of shallow soil contamination must be implemented or continued, as needed following evaluation of the treatability study that is currently in progress.
- The remedy (immediate response and removal actions) at SA100 is complete and protective of human health and the environment. Confirmation samples show that no contamination above background levels/regulatory cleanup levels remains and the site is acceptable for unlimited use and unrestricted exposure.

Table B-1 (Continued)

Operable Unit (matrix and units)	COPCs (Final ROD COCs in bold)	Former Standard/ Cleanup Level (in ROD)	Current Federal Cleanup Level†	Current Alaska Cleanup Level†	Is there a newly promulgated cleanup level or, is the new level more stringent? (Y/N)[1] If Yes, then go to Table B-2
water) µg/L	Diethyl phthalate	--	--	23,000 (B)	Y
	TCE	5	5	5(A)	N
	Benzene	5	5	5 (A)	N
	Ethylbenzene	700	700	700(A)	N
	Toluene	1,000	1,000	1,000 (A)	N
	Xylenes, total	10,000	10,000	10,000 (A)	N
	TFH-Diesel (TAH)[c]	10	--	10 (B)	N[c]
	TFH-Gas (TAqH)[c]	10	--	15 (B)	N[c]
	Aluminum	50-200	--	87 (B)	N
	Barium	2,000	2,000	2,000 (A)	N
	Manganese	50	50	50 (B)	N
	Selenium	50	50	5 (A)	Y
OU5 (Surface Water) µg/L	1,1,1-trichloroethane	200	--	200 (B)	N
	1,2-dichloroethane	5	3.8	5 (B)	Y
	Benzene	5	12	5 (B)	N
	Ethylbenzene	700	3,100	700 (B)	N
	Toluene	1,000	6,800	1,000 (B)	N
	Naphthalene	--	--	700(B)	Y
	TCE	5	27	5 (B)	N
	Trans-1,2-dichloroethene	100	--	100(B)	N
	Xylenes, total	10,000	--	10,000(B)	N
	Sheen	No Sheen	--	No Sheen (B)	N
	TFH-Gas (TAH / TAqH)[c]	10	--	10 / 15 (B)	N[c]
	JP-4	10	--	2,000[g] (A)	N
OU6 (Ground water) µg/L	**Benzene**	5	5	5 (A)	N
	Ethylbenzene	700	700	700(A)	N
	Toluene	1,000	1,000	1,000 (A)	N
	Xylenes, total	10,000	10,000	10,000 (A)	N
	1,2-Dichloroethane	5	5	5 (A)	N
	Methylene Chloride	5	5	5(A)	N
	bis(2-ethylhexyl)phthalate	6	6	6 (A)	N
	1,1,1-Trichloroethane	200	200	200 (A)	N
	1,1,2-Trichloroethane	5	5	5 (A)	N
	1,1,2,2-Tetrachloroethane	0.43[h]	--	4 (A)	Y
	TCE	5	5	5(A)	N
	Chloroform	100	100	100 (A)	N
OU6 (Soils[3]) mg/kg	**DRO**	2,000	--	2,000[g]	N
	GRO	1,000	--	1,000[g]	N
	BTEX	100	--	See individual	N
	Benzene	0.5[i]	--	0.02	Y
	Ethylbenzene	--[i]	--	5.5	Y
	Toluene	--[i]	--	5.4	Y
	Xylenes, total	10	--	78	N
	Kerosene (RRO)	2,000	--	2,000[g]	N
	1,1-Dichloroethene	--	--	0.03	Y
	1,1-Dichloroethane	--	--	12	Y
	1,1,2,2-tetrachloroethane	--	--	0.017	Y

Table B-1 (Continued)

Operable Unit (matrix and units)	COPCs (Final ROD COCs in bold)	Former Standard/ Cleanup Level (in ROD)	Current Federal Cleanup Level†	Current Alaska Cleanup Level†	Is there a newly promulgated cleanup level or, is the new level more stringent? (Y/N)[1] If Yes, then go to Table B-2
	1,1,1-Trichloroethane	--	--	1.0	Y
	2-Methylphenol (o-cresol)	--	--	7	Y
	Acetone	--	--	10	Y
	Arsenic	9.31[e]	--	2	N[e]
	Barium	196.45[e]	--	1,100	N
	Benzo(a)anthracene	--	--	6	Y
	Benzo(a)pyrene	--	--	1	Y
	Beryllium	0.76[e]	--	42	N
	bis(2-ethylhexyl)phthalate	--	--	590	Y
	Chloroform	--	--	0.34	Y
	Chromium	48.44[e]	--	26	N[e]
	Fluorene	--	--	270	Y
	Fluoranthene	--	--	2100	Y
	Indeno(1,2,3,-cd)pyrene	--	--	11	Y
	Lead	10.13[e]	--	400	N
	Methylene chloride	--	--	0.015	Y
	Naphthalene	--	--	21	Y
	Nickel	71.79[e]	--	87	N
	Pyrene	--	--	1,500	Y
	Selenium	0.54[e]	--	3.5	N
	Silver	1.68[e]	--	21	N
	Vanadium	101.64[e]	--	710	N
	Zinc	90.01[e]	--	9,100	N

* Some metals listed as COPCs in the ROD that had background levels higher than the maximum detected level are not listed.
† For water, the strictest of 18 AAC 70 and 18 AAC 75 used for State cleanup levels (origin of State criteria clarified by bold alpha notation following the criteria, as indicated below) and Federal cleanup levels are from 40 CFR 141 for groundwater and 40 CFR 131 for surface water. For soils, 18 AAC 75, Table B1 Method 2, under-40-inch zone applies for all compounds except DRO, GRO, and RRO (see note g).

(A) 18 AAC 75, Table C, Alaska Oil and Hazardous Substances Pollution Control Cleanup Regulations

(B) 18 AAC 70, Alaska Water Quality Standards

[1]If the current MCL or criteria is new (i.e., there was no standard at the time of the ROD), or if the current MCL or criteria is more stringent than the standard at the time of the ROD, then go to Table B.2 to determine whether a risk evaluation is required.
[2]Identified in ROD as a final contaminant of concern, but no cleanup level was assigned to this chemical.
[3]Soil cleanup levels applicable to SD15, except for lead at LF02. The ROD did not specify COCs for the other sites in OU 6.
[a] Surface water criteria established under 18 AAC 70, based on total aromatic hydrocarbons.
[b]The combination of benzene, ethylbenzene, toluene, and total xylenes (BTEX) in surface water may not exceed 10 µg/L.
[c]The ROD identified TFH-gas and/or TFH-diesel from 18 AAC 70, which have since become outdated. In 1998, an agreement with ADEC and EPA was made to replace the outdated TFH analyses with TAH and TAqH. Because TFH is no longer used, the current criteria shown are for TAH and TAqH and are consistent with current RAOs for OU 5.
[d]Secondary Drinking Water MCL (18 AAC 80). Secondary criteria mainly affect the aesthetic quality of drinking water.
[e]ROD-specified limit based on elevated background levels; therefore, cleanup level is still protective and no further evaluation is needed.
[f]ROD cleanup levels are based on total hydrocarbons. Current State criteria listed for DRO and GRO (18 AAC 75, Table C).
[g]This Criteria is from 18 AAC 75, Table C (groundwater) for RRO. To correspond with ROD-specified cleanup levels, Table A1, Method 1, Level D was used for soils. Kerosene and JP-4 are comparable to RRO in current State criteria
[h]ROD-specified risked-based cleanup level applies to site LF02 only. The ROD did not specify a cleanup level for this analyte at SD15, WP14, and LF04. Further evaluation in Table B.2 applies to these sites.
[i]The ACM Level C guideline for benzene, toluene, ethylbenzene, and xylenes (BTEX) combined is 50 mg/kg.

"—" Indicates no criteria/MCL or not applicable
µg/L – microgram per kilogram
mg/kg—milligrams per liter
COC—Contaminant of concern
COPC—Contaminant of potential concern
MCL – maximum contaminant level
OU – Operable Unit
ROD – Record of Decision
RRO—residual range organics
TFH—total fuel hydrocarbons

Table B-2 (Continued)

Operable Unit (matrix and units)	COPCs With New or Changed Standard (Final ROD COCs in bold)	Current Applicable Standard	Max. Detected Level at ROD[1]	2002 Max. Detected Level[2]	New Risk Evaluation Needed? [3] (Y/N)	Calculated Hazard or Risk [4]
OU5 (Surface Water) µg/L	Naphthalene	700	1	ND (0.59)	N	--
	1,2-Dichloroethane	3.8	2.6	--	N	--
OU6 (Groundwater) µg/L	1,1,2,2,-Tetrachloroethane[b]	4	8.6	0.93	N	--
OU6 (Soils[5]) mg/kg	Benzene	0.02	0.038	0.0064	N	--
	Ethylbenzene	5.5	22.2	ND (0.0048)	N	--
	Toluene	5.4	39.7	0.0032	N	--
	1,1-Dichloroethene	0.03	0.026	ND (0.0029)	N	--
	1,1-Dichloroethane	12	0.881	ND (0.0048)	N	--
	1,1,2,2-Tetrachloroethane	0.017	97.9	0.0015	N	--
	1,1,1-Trichloroethane	1.0	9.2	ND (0.0048)	N	--
	2-Methylphenol (o-cresol)	7	.0471	ND (1.54)	N	--
	Acetone	10	0.224	0.187	N	--
	Benzo(a)anthracene	6	0.23	0.183	N	--
	Benzo(a)pyrene	1	0.184	0.0208	N	--
	bis(2-ethylhexyl)phthalate	590	2.23	ND (0.77)	N	--
	Chloroform	0.34	0.15	ND (0.0019)	N	--
	Fluorene	270	0.020	0.00397	N	--
	Fluoranthene	2100	0.345	1.020	N	--
	Indeno(1,2,3,-cd)pyrene	11	0.024	0.00555	N	--
	Methylene chloride	0.015	0.012	0.0039	N	--
	Naphthalene	21	2.47	0.0117	N	--
	Pyrene	1,500	0.516	1.220	N	--

[1]Maximum detected levels are from the original risk assessment performed in conjunction with the ROD for each OU.
[2]2002 Analytical data were reviewed for current maximum detected levels. Data are not available for all of the COPCs.
[3]A new risk evaluation/calculation is considered necessary if the most recent recorded levels exceed the new/changed current standards, unless otherwise stated.
[4]For contaminants with a "Y" in the previous column, Hazard was calculated for chemicals that are non-carcinogens or Risk was calculated for carcinogens. Refer to Table B.3 for detailed calculations.
[5]Soil cleanup levels applicable to SD15, except for lead at LF02. The ROD did not specify COCs for the other sites in OU 6.
[a]PCB was only detected in one out of 38 samples. Because subsequent sampling events failed to confirm it's presence or validity of data, this compound was not included as a final COC.
[b]Maximum detected level at sites SD15, WP14, and LF04 occurred at SD15. A ROD-specified risked-based cleanup level of 0.43 µg/L applies to site LF02, which has higher maximum detected levels.

"--" not applicable or not available
mg/kg—milligrams per liter
µg/L – microgram per liter
ND – not detected, maximum detection limit shown in parentheses.
COC—Contaminant of concern
BTEX—benzene, toluene, ethylbenzene, and total xylenes
HI = Hazard Index
OU – Operable Unit
ROD – Record of Decision

Table B-3
Risk/Hazard Estimates for Chemicals with Concentrations above New Standards

Operable Unit	Chemical	Site Concentration	Standard	Hazard[a]	Risk[b]
Groundwater (ug/L)			[c]		
OU1	1,1,2,2-Tetrachloroethane	18	4	--	5E-05
OU5	1,1,2,2-Tetrachloroethane	6.2	4	--	2E-05
Surface water (ug/L)					
OU2	1,2 Dichloroethane	5.7	3.8	--	2E-05
Soils (mg/kg)			[d]		
OU4	1,1,1-Trichloroethane	2.9	460	0.006	--
	Benzene	0.043	9	--	5E-08
	Methylene chloride	0.092	180	--	5E-09

NOTES:

Calculations were performed based on equations from ADEC Cleanup Levels Guidance (November 2002). Groundwater calculations are based on Equations 1 and 2 for non-carcinogens and carcinogens, respectively. Soil calculations are based on Equations 6 and 7 for carcinogenic and non-carcinogenic volatile contaminants, respectively.

[a] Chemicals with values in this column are non-carcinogens; therefore, the hazard, rather than the risk, is estimated: site concentration/standard = hazard. Standard is based on a hazard of 1.

[b] Chemicals with values in this column are carcinogens; therefore, the risk is estimated: (site concentration/standard) x 1 x 10^{-5} = risks. Standard is based on a risk of 1 x 10^{-5}.

[c] 18 AAC 75, Table C. Groundwater standard is based on drinking the water, no bathing (inhalation, dermal) risks/hazards are included. The State only considers ingestion hazards/risks when establishing their risk-based groundwater standards.

[d] 18 AAC 75, Table B1, Under 40-Inch Zone, Inhalation. The State's soil standards presented on this table are based on inhaling vapors from the soil, the direct contact pathway of most concern for volatile chemicals at this site. Hazards/risks due to ingestion are not included but would not significantly increase risk/hazard estimates.

Section 1.0
INTRODUCTION

1.1 Purpose

The purposes of this five-year review are to evaluate the implementation and performance of the remedial actions that were selected in each Record of Decision (ROD) for Operable Unit (OU) 1, OU2, OU4, OU5, OU6 and SA100 at Elmendorf Air Force Base (AFB), Alaska (see Figure 1 in Attachment A) and to determine whether these actions are protective of human health and the environment. The methods, findings, and conclusions of reviews are documented in Five-Year Reviews. Five-Year Reviews identify issues found during the review, if any, and provide recommendations to address them. This five-year review covers activities and conditions since the previous five-year review of Elmendorf AFB conducted in 1998.

This is the second five-year review for Elmendorf AFB. This review is a post-Superfund Amendments and Reauthorization Act (SARA) United States Environmental Protection Agency (EPA) policy review that is required because contaminants remain at the site above levels that allow for unlimited use and unrestricted exposure. The start of construction of the OU2 Interim Remedial Action (IRA) on August 5, 1993 triggered the first five-year review requirement, which was completed and signed by the EPA representative on November 4, 1998—the trigger date for this subsequent five-year review.

The United States Air Force (USAF) 3rd Civil Engineering Squadron (CES), Environmental Restoration has conducted this policy five-year review pursuant to the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), 42 USC 9621(c), the National Contingency Plan (NCP), Executive Order 12580 (January 23, 1987), and Section 19.1 of the Federal Facility Agreement (FFA) for Elmendorf AFB dated September 1991. CERCLA §121 states:

> *If the President selects a remedial action that results in any hazardous substances, pollutants, or contaminants remaining at the site, the President shall review such remedial action no less often than each five years after the initiation of such remedial action to assure that human health and the environment are being protected by the remedial action being implemented. In addition, if upon such review it is the judgment of the President that action is appropriate at such site in accordance with section [104] or [106], the President shall take or require such action. The President shall report to the Congress a list of facilities for which such review is required, the results of all such reviews, and any actions taken as a result of such reviews.*

The agency interpreted this requirement further in the NCP; 40 Code of Federal Regulations (CFR) § 300.430(f)(4)(ii) states:

> *If a remedial action is selected that results in hazardous substances, pollutants, or contaminants remaining at the site above levels that allow for unlimited use and unrestricted exposure, the lead agency shall review such action no less often than every five years after the initiation of the selected remedial action.*

This document is consistent with the EPA Office of Solid Waste and Emergency Response (OSWER), Comprehensive Five-Year Review Guidance, No. 9355.7-03B-P (June 2001). Consistent with the FFA, the project managers for the EPA and the State of Alaska Department of Environmental Conservation (ADEC) have participated in this review. This review is limited to only those sites being remediated under CERCLA authority and include OU1, OU2, OU4, OU5, OU6, and

SA100. Areas not covered in depth are OU3, SS83, DP98, and SA99 (a brief description is included in Table 1-1).

1.2 Overview

This five-year review was conducted between December 2002 and August 2003 by the project team, consisting of the USAF Remedial Project Managers and Environmental Scientist/Engineer for each OU or area. This included a review and evaluation of the ROD requirements, the work that has been done to satisfy those requirements, current and past monitoring data, the current status of the remedies and the physical condition of the sites, as well as visits to each OU where action has been performed or is in progress. This review addresses active sites, although it should be noted there are several sites at some of the OUs that were completed and designated as no further action (NFA) at the time the ROD was signed. Land use controls (LUCs), discussed in detail in Section 4.7, are maintained at each OU until it is demonstrated that site contaminant concentrations are at or below levels that allow for unlimited use and unrestricted exposure (Note: the RODs use the term *institutional controls* which the USAF refers to as LUCs). Following written regulatory concurrence, where applicable, that all response actions are complete (i.e., cleanup levels have been met, no land use controls are in effect, and no additional funds will be expensed), the USAF considers a site "closed". Review of most of the OUs was done concurrent with preparation of individual site five-year review reports, which were compiled and used to prepare this overall review. This basewide five-year review report was then drafted and subjected to a series of peer and agency reviews. Table 1-1 gives a brief description and status of all OUs at Elmendorf AFB.

Table 1-1

Operable Units Status, Elmendorf AFB

OU	Sites	Included in this review?	Description	Status
OU1	LF05, LF07, LF13, SS19 (NFA), OT56, and LF59	Yes	OU1 consists of five general waste disposal areas where various types of material were disposed. The ROD (1994) focused on groundwater monitoring and LUCs.	These efforts are ongoing.
OU2	ST20 (NFA), and ST41	Yes	OU2 includes two former underground storage tank (UST) sites: ST20 and ST41. The tank at ST20 was cleaned and demolished in 1990. An interim ROD (1992) for the groundwater contamination at ST41 resulted in the installation of a free product and dissolved phase recovery treatment system in 1993. The ROD (1995) designated ST20 as NFA and focused on ST41. The 4 USTs and wood piping were cleaned and buried in place, the tanks were filled with inert material in 1996 and the contaminated soil was treated on base. The steel piping was removed, decontaminated, and recycled.	The treatment system performed as designed. Beginning in February 1997, no recoverable quantities of fuel product were observed and the system was shut down in April 1999. Long-term groundwater and surface water monitoring is ongoing.

Table 1-1 (Continued)

OU	Sites	Included in this review?	Description	Status
OU3	SD16 (NFA), SS21 (NFA), SD31 (NFA) and SD52 (NFA)	No	OU3 consisted of 3 sources and one receptor area. Polychlorinated biphenyl (PCB)-contaminated soils were excavated and disposed in 1998. The 1998 five-year review reported confirmation samples were below ROD-defined cleanup levels, allowing unlimited use and unrestricted exposure.	Not included in this five-year review because this OU has been closed and it is documented in the 1998 five-year review that cleanup levels have been met.
OU4	SS10, SS18 (NFA), FT23, SD24, SD25, SD26 (NFA), SD27 (NFA), SD28, SD29, and SD30 (NFA)	Yes	OU4 consists of 10 source areas including maintenance facilities, a fire training area, and an asphalt drum storage/processing area. During 1993 and 1994, asphalt and asphalt-containing soils at SS10 were removed. The ROD focused on semi-annual monitoring to assess contaminant migration and natural attenuation progress, and LUCs to attain cleanup levels in shallow groundwater and shallow soils and in-situ bioventing to treat deep soils. Soils were monitored bi-annually through May 1997 and annually thereafter, to evaluate migration and timely reduction of contaminants by the remedy.	LUCs, monitoring, natural attenuation, and bioventing efforts are ongoing. Soil sampling is conducted at select bioventing sites as required in preparation for closure.
OU5	ST37, ST38 (NFA), SD40 (NFA), SS42 (NFA), ST46 (NFA) and SS53 (NFA)	Yes	OU5 is located along the southern boundary of the base and upgradient shallow groundwater that migrates to this area is treated in OU5. The 1995 ROD called for removal and treatment of soil at ST37; natural attenuation and monitoring to estimate rate of natural attenuation of shallow aquifer, seep, and surface water (groundwater monitored by Basewide Groundwater Monitoring Program); passive drainage of seep water to a constructed wetland treatment system; gravel placed at seep areas; and LUCs prohibiting groundwater usage.	Contaminated soils were removed from ST37 and the soils treated by 1999. Natural attenuation, monitoring, and operation and maintenance (O&M) of the wetland treatment system are ongoing.
OU6	LF02, LF03 (NFA), LF04, SS19 (NFA), WP14, SD15, and SD73 (NFA)	Yes	OU6 consists of six source areas. Another source area, SS19, was originally part of OU7, later moved to OU6, and cleaned up in 1995. The 1997 ROD designated SS19, LF03 and SD73 as NFA and selected remedies for the remaining sites included groundwater monitoring (by Basewide Groundwater Monitoring Program), removal of free product from the water table at LF04 and WP14, debris removal from the beach at	Debris removal and soil cover placement at LF02 are completed. Groundwater monitoring, LF04 beach debris removal, free product removal at monitoring wells, and LUCs are ongoing. O&M of the SD15 high-vacuum extraction

Table 1-1 (Continued)

OU	Sites	Included in this review?	Description	Status
			LF04, groundwater treatment at SD15, LUCs, and surface debris removal and cover at LF02.	(HVE) treatment system is ongoing.
NA	SS83	No	SS83 is a World War II-vintage anti-aircraft artillery site (Battery D, 96th Antiaircraft Artillery) located near Six-Mile Creek on the northwest side of the base, adjacent to Knik Arm. This area is uninhabited, vegetated, and restricted. The Engineering Evaluation/Cost Analysis (EE/CA) began in 2000, and ten areas within SS83 were investigated. Diesel range organics (DRO) and residual range organics (RRO) were found in six areas. ADEC approved a cleanup action to remove approximately 200 cubic yards of petroleum, oil, and lubricant (POL)-contaminated soil.	Not included in this 5-year review, because site is in the investigative stage. The cleanup is programmed for fiscal year (FY) 2004. The dumpsite discovered during the EE/CA will be investigated during 2003. A decision document, based on the investigation, is due in March 2004.
NA	DP98	No	DP98 is northwest of Building 18224 in the northwest portion of the base. Investigations have found that solvent-contaminated groundwater contains chlorinated solvent and fuels in excess of cleanup levels. The proposed plan includes a preferred alternative of limited source removal, off site treatment and disposal, and monitored natural attenuation of groundwater.	Not included in this 5-year review because a ROD has not yet been completed. The public comment period for the proposed plan is complete and a ROD is being drafted.
NA	SA99	No	SA99 is a former drum dump located on the north side of Airlifter Drive, across from Hangar 18. Drums were discovered during the replacement of aboveground storage tanks in 1998. Limited investigations in 1999 discovered some POL contamination and some evidence of the herbicide Silvex (2,4,5-trichlorophenoxy propionic acid).	Not included in this 5-year review because it is in the investigative stage. Fieldwork is in progress (Summer 2003). The EE/CA report will be produced in March 2004 and removal action is planned for FY 2009.
NA	SA100	Yes	SA100 is near the Boniface entrance to Elmendorf AFB, where a rubble debris dump was discovered during construction of new housing in 2001. Suspect contaminated soils resulted in the site being designated under CERCLA. Contaminated soils were excavated from the site and confirmation samples were within acceptable limits. A closure decision document was signed in May 2002.	This site has been closed. SA100 will not be included in subsequent five-year reviews because no contaminants remain at the site above levels that would prevent unlimited use and unrestricted exposure.

Section 2.0
SITE CHRONOLOGY

Important site events and relevant dates in the site chronology for each site covered in this five-year review are shown in Table 2-1.

Table 2-1
Chronology of Site Events, Elmendorf AFB

Event	OU1	OU2	OU4	OU5	OU6	SA100
Initial discovery of contamination and/or Preliminary Assessment[a] (sites in parentheses)	• 1983 (LF05, LF07, LF13) • 1990 (OT56) • 1991 (LF59)	• 1982 (ST41) • 1986 (ST20)	• 1983 (FT23, SD24, SD25, SD26, SD27, SD28, SD29, SD30) • 1988 (SS10, SS18)	• 1983 (ST37, ST38, SS42, SD40, ST46) • 1988 (SS53)	• 1983 (LF03, LF04, WP14, SD15) • 1988 (LF02) • 1993 (SD73)	• 2001
Site Investigations	1986, 1988, 1990	1986, 1988, 1990	1986, 1990	1990	1988, 1990, 1993	2001
National Priorities List (NPL)	August 1990: Elmendorf AFB was placed on the NPL list.					
FFA Signature	November 1991: FFA negotiated between Elmendorf, EPA, and ADEC.					
Removal Actions (sites in parentheses)	1995-96 (LF59)	1990 (ST20)	1993-94 (SS10)	--	1995 (SS19)	June 2001 to April 2002
IRA ROD	--	Dec. 1992	--	--	--	--
Remedial Investigation/ Feasibility Study (RI/FS) Complete	January 1994	March 1994	September 1994	March 1994	December 1995	--[b]
ROD Signed	September 1994	May 1995	October 1995	February 1995	January 1997	--[b]
NFA Decision Documents (sites in parentheses)	--	1995 (ST20)	1993 (SD26, SD27, SD30, SS18)	1994 (ST38, SS42, SD40, ST46, SS53)	1997 (SS19, LF03, SD73)	2002[a]
Remedial Design/ Remedial Action Scope of Work	May 1995	June 1995	October 1995	February 1996	April 1997	June 2001
Remedial Design Complete	--	--	September 1995	January 1996	September 1996	--
LUCs Implemented	March 1994	March 1995	June 1998	July 1998	August 1998	--
Remedial Action Start	May 1995	•September 1993: IRA •July 1996: Tank Closure	November 1995	June 1996	June 1996	June 2001
Construction Dates (start—finish)	--	1993 (IRA), May—October 1996 (tank)	October—November 1995	June 1996—1997	October — November 1996	August—September 2001
Five-Year Reviews	November 4, 1998	November 4, 1998	November 4, 1998	November 4, 1998	November 4, 1998	--
NPL Site Completion date	*Mach 2010—Expected NPL Completion Date for Elmendorf AFB.*					
Draft Close-Out Report	*March 2011—Expected date for draft Close-Out Report for Elmendorf AFB.*					
Final Close-Out Report [c]	*October 2034—Expected date for Final Close-Out Report for Elmendorf AFB.*					
Deletion from NPL [b]	*October 2035—Expected date for Elmendorf AFB to be taken off NPL List.*					

[a]The Preliminary Assessment was a records search conducted as part of the USAF Installation Restoration Program
[b]SA100 is located within OU6 South, therefore the RI/FS for OU6 was used. EPA has agreed that a site closure document that records the conservative cleanup levels used as well as documentation in this 5-year review would be sufficient to document site closure and preparation of a ROD for SA100 would be unnecessary.
[c]This date may be revised after the ROD for DP98 is signed.
"--"—Not Applicable

Section 3.0
BACKGROUND

3.1 Elmendorf Air Force Base Land Use and Site Description

3.1.1 Land Use

Elmendorf AFB is composed of 13,103 acres and is within the Municipality of Anchorage, Alaska. It is bound on the west and north by the Knik Arm of Cook Inlet and on the east by Fort Richardson Army Installation (see Figure 1, Attachment A). Immediately to the south of Elmendorf AFB lies urban development within the Municipality of Anchorage. Land use varies across the site and consists of military support uses including industrial, commercial, residential, recreational, and undisturbed/vacant. The vast majority of the contaminated sites are located in or adjacent to industrial/commercial areas. Off base, the land use is a mixture of industrial and residential. Two residential areas (Mountain View and Government Hill) are immediately adjacent to Elmendorf AFB. No CERCLA sites are located in the immediate vicinity of these areas.

3.1.2 Geology

Glacial and related deposits including terminal moraines, ground moraines, and glacial outwash plains are the dominant regional landforms on Elmendorf AFB and in the surrounding area. The most distinctive landform at Elmendorf AFB is the Elmendorf Moraine, a southwest-northeast trending terminal moraine. The moraine consists of horizontally and vertically discontinuous, unconsolidated glacial till with poorly sorted boulders, gravel, sand and silt deposits. Finer-grained clay lens deposits are found throughout the moraine and may result in zones of perched groundwater. The southern boundary of the moraine is visible as a rising bluff line along the north side of Elmendorf's east-west runway. Moraine elevations range from 200 to 300 feet above mean sea level.

Landform features formed by glacial activity can be seen north of the Elmendorf End Moraine in the form of drumlins, eskers, kame terraces, and kettle lakes. Elevations in this area range from 125 to 210 feet and gently slope to the east.

South of the Elmendorf Moraine lies the glacial outwash plain alluvium. The alluvium deposits were formed by a series of coalescing streams resulting from glacial melt water. These outwash plain deposits consist of unconsolidated fine- to medium-grained, poorly sorted sand and gravel. Elevations range from 100 to 225 feet above mean sea level. Relief is generally flat, and gently sloping to the south-southwest. Most of the developed areas on Elmendorf AFB are built on the outwash plain alluvium and over 90 percent of the contaminated sites are located in this area.

Underlying glacial moraine and outwash deposits are shallow marine deposits of the Bootlegger Cove formation. The Bootlegger Cove formation is a fine-grained glacioestuarine deposit consisting of silt and clay. Depth to the Bootlegger Cove formation ranges from 1 to 60 feet below ground surface near the moraine and from 75 to 100 feet below ground surface throughout the outwash plain. Overall, the formation is thought to be a least 125 feet thick and may be more than 250 feet thick in certain locations.

3.1.3 Groundwater

Two principal groundwater aquifers have been identified in the glacial outwash plain alluvium and on the Elmendorf Moraine. These aquifers include a shallow unconfined aquifer (shallow aquifer), and a deeper confined regional aquifer. The Bootlegger Cove formation acts as the confining layer between the shallow and deep aquifers. In general, groundwater flow direction in the shallow aquifer matches closely that of the surface topography. Subsurface flow is to the northwest along the north limb of the moraine, and to the southeast along the south limb. The groundwater divide coincides with the crest of the moraine. The shallow aquifer on Elmendorf AFB is not used for drinking water.

The deeper confined aquifer is a regional aquifer that underlies all of Elmendorf AFB. Groundwater flow direction to the confined aquifer is westerly from the Chugach Mountains toward Knik Arm. Groundwater from the deeper confined aquifer at Elmendorf AFB serves only as a standby drinking water supply when surface water supplies cannot meet the demand. However, the municipal area bordering Elmendorf AFB uses groundwater for various services including industrial, commercial, domestic, and public supply. Based upon groundwater monitoring data, there is contamination in portions of the shallow aquifer on-site. However, the deeper confined aquifer has not been impacted by any contaminants from sources on Elmendorf AFB. The Bootlegger Cove formation seems an effective barrier between the aquifers; there is no evidence that they are hydraulically interconnected.

3.1.4 Surface Water

Elmendorf AFB has four major drainage basins and a number of natural and man-made lakes and ponds (Attachment A, Figure 1). The major drainage systems include Ship Creek, Six-Mile Creek, EOD Creek, and Cherry Hill Ditch. Ship Creek is the largest surface water drainage system on Elmendorf AFB. It originates in the Chugach Mountains to the east, runs along Elmendorf's southern boundary and empties into the Knik Arm. The upper Ship Creek basin is an important recharge area for the deeper confined aquifer and provides approximately one quarter of total recharge to the system. Six-Mile Creek and EOD Creek are located north of the Elmendorf Moraine. Six-Mile Creek originates as springs located near the Elmendorf AFB and Fort Richardson boundary. Cherry Hill Ditch is the major storm water drainage system for the main base area south of the Elmendorf Moraine. Elmendorf AFB has 12 natural and manmade lakes and ponds varying from one acre to 123 acres in size. The vast majority of these water bodies are located north of the Elmendorf End Moraine.

3.2 Site History

3.2.1 History of Contamination

Elmendorf AFB operations since the mid-1940s have generated varying quantities of hazardous and non-hazardous wastes from industrial and airfield operations, fire training and fuels management. In August 1990, Elmendorf AFB was placed on the NPL, bringing it under the federal facility provisions of CERCLA Section 120, as mentioned previously.

To date, the USAF has identified 85 sources of contamination from historic operations that occurred prior to 1984. These sources have been grouped into three major divisions: CERCLA sources, state program sources, and other program sources.

Forty of the 85 source areas are designated as CERCLA sources. Thirty-seven of these have been grouped into six OUs as depicted on Figure 1 in Attachment A and remedial activities are being conducted under the FFA. The other three of these CERCLA sources are SS83, DP98, and SA99 and these sites are currently in the investigative stage.

Forty other source areas have been designated as state program sources and remedial activities are being performed according to State of Alaska regulations. These areas are not included in this five-year review. The remaining five source areas were initially identified as historical sources but on further investigation were determined to be Resource, Conservation and Recovery Act (RCRA) sources. These sites were transferred to Elmendorf's Environmental Compliance Section, and are not included in this five-year review.

3.2.2 Initial Response

Initial response actions, prior to the signing of the ROD(s), were conducted at some OUs:

- An asphalt recovery effort was conducted at LF59 (OU1) during 1995 and 1996 field seasons. Over 10,000 gallons of liquid asphalt was excavated and recycled as part of the State cleanup program.

- At ST41 in OU2, an oil/water separator was installed in 1976 to reduce the amount of fuel being discharged to a drainage ditch adjacent to Fairchild Ave. Monitoring wells were sampled in 1984 and 1988. In 1989 a small dam was placed in a nearby drainage ditch. After the IRA ROD was signed in 1992, a free-product and dissolved-phase recovery treatment system was installed at ST41.

- In 1983, storage of waste liquids in a tank at ST20 in OU2 was prohibited. Then, in 1986 about 105,000 gallons of liquid waste were removed from the tank. The source (tank, piping, and 1,300 cubic yards of contaminated soil) was removed and the soil treated during 1990. The OU2 ROD (1995) recommended NFA for ST20 because it was demonstrated that soil was cleaned up and the source of groundwater contamination was due to upgradient sources (i.e., ST48 in the State Program).

- During the fall of 1993 and summer of 1994, a response action at SS10 in OU4 removed both liquid asphalt and asphalt-containing soils left over from former asphalt batch operations. More than 100,000 gallons of asphalt were recovered and recycled for reuse on base. In-situ bioventing to treat deep soils potentially contributing to contaminants in groundwater is ongoing.

- Removal of the underground storage tank and contaminated soils in the vicinity of Pump House Building (PL81) was completed in 1996 as part of the State cleanup program. The pump house was also removed from service at this time. The former pipeline and valve pit area associated with PL81 is an adjacent upgradient source area to WP14 and LF04 South in OU6. To decrease the suspected source of hydrocarbon contamination, a performance-based contract is planned to address the PL81 Valve Pit 11 area.

- At LF02 in OU6 (South), landfill debris on top of or protruding from the ground surface was removed in October 1996. At that time, a limited soil cover was applied in three areas that had elevated lead contamination, limiting that exposure pathway.

- In 2001, an unexpected amount of buried debris, suspected to contain asbestos or lead-based paint, was discovered during excavation of new utility trenches at an area near the Boniface entrance to Elmendorf AFB. Other excavations on site uncovered a vein of saturated soil that had a strong volatile odor. Within two weeks, the site was provided with a CERCLA designation (SA100) and cleanup activities were initiated under a CERCLA "time critical removal action". Following the removal action, confirmation soil samples confirmed that all metal concentrations above background levels and all petroleum-contaminated soils above regulatory criteria had been removed. The USAF and the EPA determined that because the conservative ADEC cleanup level of 400 milligrams per kilogram (mg/kg) for lead was used, a site closure document as well as documentation in this five-year review would be sufficient to demonstrate concurrence for site closure and preparation of a ROD for SA100 would be unnecessary. The USAF considers SA100 closed and this site will not be included in subsequent five-year reviews (USAF, 2002c).

3.2.3 Basis for Taking Action

Due to past operations, substances have been released at Elmendorf AFB that have resulted in contamination of soil, surface water and groundwater (Refer to individual RODs specified in Section 12 for more detail). The initial risk assessment determined the human and/or ecological risks exceeded EPA's average or reasonable maximum exposure risk management criteria. Table 3-1 summarizes the final contaminants of concern (COCs) specified in the RODs for each OU.

Table 3-1

Contaminants of Concern, Elmendorf AFB

Contaminants	OU1	OU2	OU4	OU5	OU6	SA100
Surface Water:						
Benzene		X				
Ethylbenzene		X				
Toluene		X				
JP-4				X		
Total Fuel Hydrocarbons (TFH)-Gas [TAH and TAqH][a]				X		
Sheen				X		
Groundwater:						
1,1,1-Trichloroethane			X			
1,1,2-Trichloroethane					X	
1,1-Dichloroethene			X			
1,2-Dibromoethane	X					
1,2-Dichloroethane			X		X	
1,2-Dichloroethene			X			
Benzene		X	X	X	X	
Ethylbenzene		X	X		X	
Manganese	X					
Methylene Chloride					X	
Tetrachloroethene			X			
TFH-Diesel [TAH] [a]				X		
TFH-Gas [TAqH] [a]				X		
Toluene		X	X		X	
Trichloroethene (TCE)	X		X	X	X	
Vinyl Chloride	X					
Xylenes		X				
Soils:						
Benzene, toluene, ethylbenzene, and total xylenes (BTEX)			X		X	
Diesel / DRO			X		X	X
Gasoline / gasoline range organics (GRO)			X		X	
RRO						X
Jet Fuel			X			
TFH-diesel				X		
Toxicity Characteristic Leaching Procedure (TCLP) metals						X
Lead					X	X
Other:						
Exposed Landfill Debris					X	X

[a] The ROD-specified analyses TFH-diesel and TFH-gas were revised in 1998 to TAH and TAqH for OU5. Because there was no standard for these COCs in groundwater, and because the groundwater emerges as surface water at the seeps that eventually end up in Ship Creek (an aquaculture resource), the aquaculture water standards for TAH and TAqH were used (18AAC70.020 ecological risk).
JP-4—a jet fuel
TAH—Total Aromatic Hydrocarbons
TAqH—Total Aqueous Hydrocarbons

Section 4.0
REMEDIAL ACTIONS

Initial plans, remedial action objectives (RAOs), selected remedy descriptions, remedy implementation history, and current status of the remedies associated with each OU are presented in this section. In addition, LUCs (referred to in the ROD as institutional controls) that have been implemented on site are also discussed separately.

4.1 Operable Unit 1

OU1 is located in the eastern portion of the base, next to Vandenburg Avenue and immediately north of Ship Creek (Figure 1, Attachment A). OU1 is over 60 acres in size and consists of five general waste disposal areas designated LF05, LF07, LF13, OT56 and LF59 (Figure 2, Attachment A). Various types of material were disposed of, including general refuse, scrap metal, used chemicals, construction debris, and drums of asphalt. A brief chronology of events occurring at OU1 has been provided in Table 2-1.

RAOs are developed to specify actions needed to protect human health and the environment. These objectives define the contaminants of concern, exposure routes and receptors, and remediation goals, which are defined as an acceptable contaminant level for each exposure route. The RAO for the OU1 source area is to prevent ingestion/direct contact with groundwater containing contaminants in concentrations in excess of background levels or maximum contaminant levels (MCLs) as required by the Safe Drinking Water Act (40 CFR), whichever is greater. The goal is to reach the ROD-specified cleanup levels shown in the following table.

Table 4-1

Cleanup Levels at OU1

Contaminant of Concern	ROD-Established Cleanup Level	Source of Requirement
Groundwater (µg/L)		
1,2-Dibromoethane	0.05	MCL
Manganese	9,100	background
TCE	5.0	MCL
Vinyl Chloride	2.0	MCL

µg/L—micrograms per liter

1,2-Dibromeoethane is an additive to leaded gasoline. TCE and vinyl chloride are solvents most likely present due to past disposal activities. Manganese is a naturally occurring metal in the soil around Anchorage and is the only compound consistently observed throughout the OU.

4.1.1 OU1 Remedy Implementation and Status

The OU1 ROD was signed on September 28, 1994 and focused on groundwater. The selected remedy at OU1 includes LUCs and groundwater monitoring to assess natural attenuation until the cleanup levels described above are met. The major components of the selected remedy and current status of each is provided in Table 4-2.

Table 4-2

OU1 Remedy Implementation Status

Remedy Component	Brief Status
Monitor groundwater for five years, or until the groundwater no longer poses an unacceptable health risk by meeting cleanup levels.	Ongoing (Basewide Groundwater Monitoring Program). Cleanup levels for 1,2-dibromoethane and vinyl chloride were met in 1996 and 1997. The manganese cleanup level has been met since June 2001.
Implement LUCs, which include: • Develop site map showing the areas currently and potentially impacted by groundwater contaminants. • Restrict land use and areas designated for recreational use. • Enforce base policy prohibiting installation of groundwater wells into the shallow aquifer. These controls will remain in effect as long as the USAF maintains active control of the area or until the groundwater contamination dissipates to such levels that will no longer pose any unacceptable human health or environmental risks.	Implemented March 1994.

Currently, groundwater at OU1 is being monitored as part of the Basewide Groundwater Monitoring Program, which includes annual evaluation of monitoring results until cleanup levels are attained. The site inspection observed that the Elmendorf AFB Municipal Solid Waste Landfill capping project was underway. The landfill cap is being conducted according to an agreement with the State and the *Municipal Solid Waste Landfill Closure Plan* (USAF, 1996a). Although this is not an action that is required by the ROD, the landfill cap is expected to result in diverting a large portion of storm water from infiltrating into the landfill, thereby limiting leachate migration and associated contaminants to groundwater in OU1. Under the current site use, direct human exposure to contaminated groundwater is prevented by LUCs that prohibit the use of water from the shallow aquifer. The annual number of wells sampled at OU1 since the previous five-year review is included in Table 4-3. Attachment C includes decision guides for monitoring well selection and analysis (Figure C-1) and monitoring well sampling frequency (Figure C-2). In addition, Figure C-3 illustrates the status of the contamination found at key wells for OU1, during the Basewide Groundwater Monitoring Program.

Table 4-3

Number of Wells Sampled at OU1, 1998 to 2002

Year	Number of Wells Sampled
1998	13
1999	14
2000	14
2001	12
2002	4

Cleanup levels have been met for all COCs at LF05, LF07, LF13, and OT56. The manganese cleanup level has been met at all wells within OU1 since 2001. TCE currently exceeds the cleanup level at LF59, which will continue to be monitored as part of the Basewide Groundwater Monitoring Program. LUCs have been established and are maintained to prevent exposure until cleanup levels are attained (see Section 4.7).

Annual system O&M costs include planning and management, sampling, monitoring, reporting, and five-year reviews. Total costs for FY 1995 through FY 2003 are presented in Table 4-4.

Table 4-4

O&M Costs for OU1, FY 1995 through FY 2003

Fiscal Year	Total Costs*
1995	$ 120,000
1996	$ 190,000
1997	$ 66,000
1998	$ 66,000
1999	$ 78,000
2000	$ 60,000
2001	$ 74,000
2002	$ 81,000[a]
2003	$ 30,000
Total Cost:	**$ 765,000**

*Total Costs are rounded to nearest $1,000. Costs are associated with the Groundwater Monitoring project, with the exception of year 2002 (see note a).
[a] Includes $1,742 for Land Use Controls Management Plan, $2,764 for Five-Year Review, and $76,228 for Groundwater Monitoring.

4.2 Operable Unit 2

OU2 consists of two source areas, ST20 and ST41 (Figure 2, Attachment A), located in the central (ST20) and western (ST41) portion of the base. ST20 is the former site of a 338,000-gallon underground storage tank that was used to store Bunker C fuel oil, waste oils, used solvents, and other wastes. Elmendorf removed the tank and contaminated soils at ST20 in 1990, which resulted in a NFA determination in the OU2 ROD (see Section 3.2.2.). ST20 is not included in this five-year review.

ST41 is the former site of four 1,000,000-gallon USTs. After the IRA ROD was signed in 1992, a free-product and dissolved-phase recovery treatment system was installed at ST41. Both of these areas are characterized by fuel spills and leaks from underground storage tanks. A brief chronology of events occurring at OU2 has been provided in Table 2-1.

RAOs were developed to specify actions needed to protect human health and the environment. These objectives define the COCs, exposure routes and receptors, and remediation goals, which are defined as an acceptable contaminant level for each exposure route. RAOs specified in the OU2 ROD are:

- Prevent ingestion and contact with groundwater containing contaminants in concentrations in excess of background or MCLs, whichever is greater;
- Prevent use for aquaculture, or if aquaculture use is proposed in the future, treat water to an acceptable level;
- Prevent contaminated seep water (surface water) from entering wetlands;
- Reduce further migration of contaminants due to free phase product currently on water table, and any residual product that may exist in piping and underground tanks;
- Prevent migration of contaminants found in soil that would result in groundwater contamination in excess of MCLs or health-based levels;

- Attain residual contaminant levels which would restore groundwater as a potential source of drinking water; and
- Compliance with all action-, chemical-, and location-specific applicable or relevant and appropriate requirements (ARARs).

Final remediation goals for groundwater include preventing ingestion or direct contact with groundwater containing contaminants with concentrations in excess of background levels or federal drinking water standards (Primary MCLs, 40 CFR 141), as shown in Table 4-5.

Final remediation goals for surface water and seeps include compliance with location and chemical specific ARARs. The location specific goal is avoidance of long- and short-term adverse impacts associated with destruction or modification of the wetlands area. The chemical specific cleanup levels include compliance with State of Alaska surface water quality criteria (18 Alaska Administrative Code [AAC] 70). The chemical-specific cleanup levels for each constituent (e.g., benzene, ethylbenzene, and toluene) were defined in the ROD based on the TAH cleanup level in 18 AAC 70, as shown in Table 4-5.

The COCs for both groundwater and surface water are fuel-related chemicals that are attributed to past operations and/or spills associated with the USTs.

Table 4-5

Cleanup Levels at OU2

Contaminant of Concern	ROD-Established Cleanup Level	Source of Requirement
Groundwater (µg/L)		
Benzene	5	MCL
Ethylbenzene	700	MCL
Toluene	1,000	MCL
Xylenes	10,000	MCL
Surface Water (µg/L)		
Benzene	10	18 AAC 70[1]
Ethylbenzene	10	18 AAC 70[1]
Toluene	10	18 AAC 70[1]

[1]Based on total aromatic hydrocarbons.

An interim ROD for the groundwater contamination at ST41 was signed in September 1992 and documents an IRA agreed to by both EPA and ADEC. The USAF implemented the IRA to remove free product floating on the groundwater, and to intercept contaminated water prior to discharge from seeps. As a result of the interim ROD, a free-product and dissolved-phase recovery treatment system was designed and constructed in 1993. The system was designed to remove product from the groundwater table and decrease off-site migration of contaminants.

4.2.1 OU2 Remedy Implementation and Status

The OU2 ROD was signed in May 1995 and focused on tank removal and continued groundwater cleanup at ST41. The ROD-specified selected remedies for OU2 include operation of the IRA system, source control through cleaning and removal, LUCs, and monitored natural attenuation. The major components of the selected remedy for OU2 (ST41) and current status of each are provided in Table 4-6.

Table 4-6

OU2 Remedy Implementation Status

Remedy Component	Brief Status
Continue operation of the free-product recovery system until: • All technically practicable free product has been recovered to mitigate the continuing source of contamination. • It can be determined that the State of Alaska Water Quality Criteria are being met at the seeps. • It can be shown that natural attenuation will be protective of the wetlands in the area.	The recovery system met the requirements and was shut down in April 1999. Monitoring of wetlands and seeps is ongoing to ensure protection.
Continue long-term monitoring of groundwater.	Ongoing since 1996 (Basewide Groundwater Monitoring Program).
Maintain LUCs that restrict access to groundwater and contaminated surface and subsurface soils.	Implemented March 1995.
Clean and abandon in-place 4 one-million gallon USTs. Excavate, remove and dispose/recycle the piping system.	Completed September 1996.
Remove contaminated soil containing leachable concentrations of fuel-related contaminants and treat offsite by low thermal treatment.	Excavation completed September 1996.

Groundwater at OU2 is being monitored as part of the Basewide Groundwater Monitoring Program. The annual number of wells and seeps sampled at OU2 since the previous five-year review is included in Table 4-7. Attachment C includes decision guides for monitoring well selection and analysis (Figure C-1) and monitoring well sampling frequency (Figure C-2). In addition, Figure C-4 illustrates the status of the contamination found at key wells in OU2.

Table 4-7

Number of Wells and Seeps Sampled at OU2, 1998 to 2002

Year	Number of Wells Sampled	Number of Seeps Sampled
1998	14	0
1999	14	0
2000	13	0
2001	12	0
2002	5	1

The recovery and treatment system began operating in 1993. Floating fuel product was observed and removed from the IRA free product recovery system each week since system startup until all technically practicable free product was recovered. As of November 1994, about 145 gallons of product were recovered from operation of the IRA. Small quantities were recovered through 1996 and from February 1997 to February 1999, no recoverable quantities of fuel product were observed. In April 1999 the system was shut down and hand-bailing methods are used monthly to recover remaining small quantities of floating free product (at wells with more than 0.1 foot free-product thickness).

The free-product recovery system at ST41 eliminated potential pathways for exposure. The surface water and groundwater that would flow into the wetland areas were being collected and treated as part of the IRA system. The wetland areas that receive the surface and seep water are in remote locations, seldom visited by humans. In addition, exposure to contaminated groundwater is prevented by LUCs that prohibit the use of the shallow aquifer. LUCs are maintained to prevent exposure until cleanup levels are attained (see Section 4.7).

Annual system O&M costs include planning and management, operation and maintenance of the free product recovery system, sampling, monitoring, reporting, and five-year reviews. Total costs for FY 1994 through 2003 are presented in the following table.

Table 4-8

O&M Costs for OU2, FY 1994 through 2003

Fiscal Year	Free Product Recovery System Operation	Groundwater and Seep Monitoring	Land Use Controls Plan	Five-Year Review	Total Costs*
1994	$189,200	--	--	--	$ 189,000
1995	$294,761	--	--	--	$ 295,000
1996	--	$38,007	--	--	$ 38,000
1997	$92,300	$84,000	--	--	$ 176,000
1998	$102,647	$84,000	--	--	$ 187,000
1999	$225,788	$74,012	--	--	$ 300,000
2000	--	$79,902	--	--	$ 80,000
2001	--	$69,126	--	--	$ 69,000
2002	--	$72,089	$1,792	$2,074	$ 76,000
2003	--	$53,989	--	--	$ 54,000
Total Cost:					**$ 1,464,000**

* Total Costs are rounded to nearest $1,000.

4.3 Operable Unit 4

OU4 is located in the central portion of Elmendorf AFB, near the main runways and consists of ten source areas that are divided into OU4 East and OU4 West areas (Figure 1, Attachment A). The source areas include floor drains in eight maintenance facilities (SD24 through SD30, and SS18), a fire training area (FT23), and an asphalt drum storage and processing area (SS10). Contamination includes fuel spills, leaking asphalt storage drums, leaking fuel distribution systems and USTs, aircraft refueling operations, aircraft maintenance activities within the hangar facilities, and incomplete combustion of fire training materials in the fire training area (FTA). Table 2-1 provides a brief chronology of events occurring at OU4.

Due to minimal soil contamination found at SS18, SD26, SD27, and SD30, these sites were designated as NFA for soil. NFA decision documents were signed in May 1993.

During the fall of 1993 and summer of 1994, a response action at SS10 removed both liquid asphalt and asphalt-containing soils left over from former asphalt batch operations. Over 100,000 gallons of asphalt were recovered and recycled for reuse on base.

RAOs were developed to specify actions needed to protect human health and the environment. RAOs specified in the OU4 ROD are applicable for all contaminated groundwater and soil areas and include:

- Protect human health and the environment by preventing ingestions of and contact with contaminated media by people;
- Protect uncontaminated media by preventing releases from sources;
- Use treatment techniques whenever practicable; and
- Implement a cost effective solution that can achieve the cleanup levels for the final COCs.

These RAOs define the site-specific COCs, exposure routes and receptors, and remediation goals, which are defined as acceptable contaminant levels for each exposure route. Table 4-9 presents a summary of the COCs and cleanup levels to be achieved as outlined in the OU4 ROD through implementation of the selected remedy.

Table 4-9

Cleanup Levels at OU4

Location	Contaminant of Concern	ROD-Established Cleanup Level	Source of Requirements
Groundwater (µg/L)			
FT23	1,1,1-Trichloroethane	200	MCL[1]
	1,1-Dichlororethene	7	MCL[1]
	1,2-Dichloroethane	6	MCL[1]
	Tetrachloroethene	6	MCL[1]
	Trichloroethene	6	MCL[1]
	1,2-Dichloroethene	70	MCL[1]
	Benzene	5	MCL[1]
SD25	Benzene	5	MCL[1]
	Ethylbenzene	700	MCL[1]
	Toluene	1,000	MCL[1]
SD24, SD26, SD27	Benzene	5	MCL[1]
SD28, SD29	Tetrachloroethene	5	MCL[1]
	Trichloroethene	5	MCL[1]
Soil (mg/kg)			
FT23	DRO	2,000	ACM[2]
	GRO	1,000	ACM[2]
SD25	DRO	1,000	ACM[2]
	GRO	2,000	ACM[2]
SS10	DRO	2,000	ACM[2]
	Jet Fuel	2,000	ACM[2]
	Xylene	100	ACM[2]
	GRO	1,000	ACM[2]

[1]40 CFR Part 131, and 18 ACC Chapter 70.010a and d, 70.015 through 70.0110, 18 AAC 80.070.
[2]ACM – Alaska Cleanup Matrix Level D, 18 AAC 78.315.
Note: There are no cleanup levels for soil at SD26, SD27, SD28, and SD29 because contaminant levels were below regulatory standards at the time of the ROD.

4.3.1 OU4 Remedy Implementation and Status

The OU4 ROD was signed on October 10, 1995 and focused on soil and groundwater. The remedy selected for subsurface soil contamination at OU4 was bioventing. Bioventing systems were installed and activated at SS10, FT23, and SD25 in November 1995. The selected remedy for groundwater is monitoring to assess contaminant migration and the timely reduction of contaminant concentrations by natural attenuation. Currently, groundwater is monitored and sampled at this OU as part of the Basewide Groundwater Monitoring Program. The major components of the selected remedy for OU4 and current status of each are provided in Table 4-10.

Table 4-10

OU4 Remedy Implementation Status

Remedy Component	Status
Intrinsic remediation (now referred to as "natural attenuation") will be relied upon to attain cleanup levels in the contaminated shallow groundwater aquifer. Groundwater will be monitored semi-annually to evaluate contaminant migration and timely reduction of contaminant concentrations.	Ongoing since 1996 (Basewide Groundwater Monitoring Program).
LUCs that prohibit the use of the shallow aquifer will prevent exposure to contaminated groundwater until cleanup levels are achieved.	Implemented June 1998.
In-situ bioventing will be used to treat deep soils (greater than 5 feet in depth) potentially contributing to contaminants in groundwater at SS10, FT23, and SD25.	Ongoing at SS10 and FT23. SD25 has reached cleanup levels and the system has been shut down.
Both shallow (less than 5 feet in depth) and deep soils will be monitored biannually to evaluate contaminant migration and timely reduction of contaminant concentrations by bioventing and intrinsic remediation.	Completed May 1997.

The selected remedy includes a combination of contaminant treatment and control of exposure pathways. A treatability study was initiated in the summer of 1995, and the bioventing systems were designed and constructed in the fall of 1995. The bioventing systems began operation in November 1995 and continue to operate at this time. A discussion of the remediation status follows:

- OU4 Groundwater. Groundwater at each of the sites within OU4 is currently monitored annually as part of the Basewide Groundwater Monitoring Program. The program was established to ensure that both OU-specific and basewide groundwater issues are addressed comprehensively. The program is modified as needed to ensure the program and remedies remain protective. Figure C-5 in Attachment C illustrates the status of the contamination found during the Basewide Groundwater Monitoring Program at key wells in OU4. In addition, Attachment C includes decision guides for monitoring well selection and analysis (Figure C-1) and monitoring well sampling frequency (Figure C-2). The annual number of wells sampled at OU4 since the previous five-year review is included in Table 4-11.

Table 4-11

Number of Wells Sampled at OU4, 1998 to 2002

Year	Number of Wells Sampled
1998	14
1999	13
2000	13
2001	7
2002	6

At FT23, there are currently groundwater plumes of TCE and benzene. The source for these plumes is incomplete combustion of fire training materials in the fire training area (FT23). Contaminants include chlorinated solvent products (1,1,1-trichloroethane and TCE) and hydrocarbons, mainly benzene. It is unclear whether natural attenuation of chlorinated solvents in the plume will be limited by the amount of carbon available.

Carbon concentrations are currently moderate but decreasing, indicating the process may slow in the future. This is an indication that, although fuels in this plume will likely meet cleanup levels by 2008 as predicted in the ROD, chlorinated solvents might not.

- SS10 Soils. Soil gas testing performed in 2001 found total volatile hydrocarbon (TVH) concentrations in deep soils that ranged from non-detect to 348 mg/kg, suggesting that low levels of petroleum are still present in the subsurface. The highest hydrocarbon degradation rate was 0.743 milligram per kilogram per day (mg/kg/day). Respiration test results indicate that the bioventing system continues to enhance remediation. Active biodegradation of hydrocarbons appears to be continuing. The system will continue to operate, and current maintenance, monitoring, and testing schedules will be maintained. Confirmation sampling at SS10 is scheduled to be performed in 2003 and lab results will indicate status of contamination remaining at this site.

  For shallow soils, sufficient natural attenuation has occurred such that cleanup levels have been reached. No further monitoring of shallow soils is being done at this site (USAF, 1998a).

- FT23 Soils. For soil at FT23, confirmation samples were collected in 1999. Nineteen of the 21 samples returned analytical data that were below cleanup levels identified in the OU4 ROD (USAF, 2000a). Results from one sample, at a location (soil boring SB-62) over 100 feet from the nearest air injection well, were above cleanup levels. In 2002, two injection wells were installed in that area to expand the current bioventing system and address contamination at this location. In addition, four soil vapor implant sets with upper and lower monitoring points were installed to evaluate system performance.

  Only one blower (FTA-1) is operating at FT23. Blower FTA-2 was shut down in 2000 because remediation at the injection well and soil vapor implant locations associated with this blower was complete (USAF, 2000a). The system achieved remediation goals within 5 years of activation. Blower FTA-1 is connected to five injection wells, two of which were installed in 2002, as described previously. Soil gas testing results from 2001 suggest only low levels of hydrocarbon contamination remain in the subsurface. In-situ respiration test data from 2001 indicate that degradation rates are at or approaching zero and further hydrocarbon degradation via bioventing is not likely to be significant at FTA-1 (USAF, 2002b). Because the levels of contamination and site conditions at the new location, soil-boring SB-62, are parallel to those encountered at FTA-1, remediation at the new location should be achieved within 5 years, meeting the cleanup duration of 10 to 15 years predicted in the ROD (USAF, 1995a).

- SD25 Soils. For shallow soils, sufficient natural attenuation has occurred such that cleanup levels have been reached. Confirmation sampling performed at SD25 in 1999, indicated that all contaminants of concern were below soil cleanup levels except benzene (USAF, 2000a). In 2002, subsequent confirmation sampling at SD25 consisted of drilling one additional soil boring and collecting one soil sample from the 14 to 16-foot interval. Results for GRO and BTEX in 2002 were significantly below cleanup levels outlined in the OU4 ROD. In March 2003, the final SD25 closure report was completed and documented cleanup objectives for the deep soils identified in the ROD for OU4 had been achieved at SD25. No further soil monitoring is being conducted at this time. Pending regulatory approval, the bioventing system at this site will be shut down.

LUCs have been established at OU4 and will continue to be maintained at each site to prevent exposure until groundwater and soil cleanup levels are attained (see Section 4.7).

4.3.2 OU4 Systems O&M

The OU4 bioventing systems are monitored regularly to ensure that the systems are operating efficiently and to estimate the mass of contamination being removed from the subsurface. System performance is evaluated using historical data, biweekly systems checks, soil gas testing and respiration testing. Several practices are in place at SS10, FT23, and SD25 to assist in operation of the system and monitor progress. They include standard O&M procedures as specified in the O&M manual (USAF, 1996b); biweekly maintenance and system checks to inspect bioventing wells, blower units, and piping; in-situ respiration testing; and soil gas checks to ensure bioventing sites are well oxygenated and to evaluate contaminant trends.

Annual system O&M costs include planning and management, operation and maintenance of the bioventing systems, sampling, monitoring, reporting, and five-year reviews. Total costs for FY 1996 through FY 2003 are presented in Table 4-12.

Table 4-12

O&M Costs for OU4, FY 1996 through FY 2003

Fiscal Year	Bioventing System Operation	Groundwater Monitoring	Land Use Controls Plan	Five-Year Review	Total Costs*
1996	$71,561	$114,022	--	--	$ 186,000
1997	--	$73,000	--	--	$ 73,000
1998	$33,413	$73,000	--	--	$ 106,000
1999	$91,095†	$71,043	--	--	$ 162,000†
2000	$26,904	$71,024	--	--	$ 98,000
2001	$34,560	$74,443	--	--	$ 109,000
2002	$72,808	$42,052	$10,750	$12,443	$ 138,000
2003	$49,631	$42,358	--	--	$ 92,000
Total Cost:					**$ 964,000**

*Total Cost are rounded to nearest $1,000.

† Costs for 1999 were higher than average due to bioventing confirmation soil sampling conducted at FT23 and SD25.

4.4 Operable Unit 5

OU5 is located along the southern boundary of Elmendorf AFB and covers an area over 7,000 feet long and 1,200 feet wide (Attachment A). In the western part of this OU, a steep bluff gives way to a broad flat area adjacent to Ship Creek. In the eastern portion of OU5, a more gently sloping bluff leads to a wetland area where there are several shallow connected water bodies and marshes. The central part of this OU is a transitional area with a bluff and some surface water features. Bulk storage of diesel fuel, jet fuel and multi-product fuel pipelines was the primary source of contamination within OU5. Upgradient sources from OU5 (OUs 1, 2, 4, and several State Program sites) are the major sources of groundwater contamination in OU5. Regardless of the source of contamination, groundwater is being treated through OU5 remedial actions. Table 2-1 includes a brief chronology of milestone events at OU5.

Due to minimal soil contamination at ST38, SD40, SS42, ST46, and SS53 (Figure 2, Attachment A), these sites have been designated as NFA sources and decision documents were signed in August 1994. ST37 is the remaining source area within OU5.

RAOs were developed to specify actions needed to protect human health and the environment. Specific RAOs specified in the OU5 ROD include:

- Protect human health and the environment by preventing ingestion and contact with contaminated groundwater by people and preventing animal contact with contaminated seep water;
- Use treatment techniques whenever practicable;
- Implement a solution that is capable of managing impacts from upgradient sources as the contaminants reach OU5; and
- Implement a cost-effective solution that can achieve the cleanup levels for the final COCs.

These objectives define the site-specific COCs, exposure routes and receptors, and remediation goals, which are defined as acceptable contaminant levels for each exposure route. The primary types of contaminants are fuel-related chemicals and solvents that are attributed to sources upgradient of OU5 where past spills or disposal occurred. The COCs and cleanup levels to be achieved as outlined in the ROD through implementation of the selected remedy are listed in Table 4-13.

Table 4-13

Cleanup Levels at OU5

Contaminant of Concern	ROD-Established Cleanup Level	Source of Requirement
Groundwater (µg/L)		
TCE	5	MCL[1]
Benzene	5	MCL[1]
TFH-diesel[2]	10	18 AAC 70.020, based on ecological risk
TFH-gas[2]	10	18 AAC 70.020, based on ecological risk
Surface Water (µg/L)		
Sheen	no sheen	18 AAC 70.020, based on ecological risk
TFH-gas[2]	10	18 AAC 70.020, based on ecological risk
JP-4[2]	10	18 AAC 70.020, based on ecological risk
Soil (mg/kg)		
TFH-diesel	1,000	18 AAC 78.315, ACM Level C

[1]40 CFR 131, 18 AAC 70.010a and d, 18 AAC 015-70.0110, and 18 AAC 80.070
[2]Since the ROD, these analyses have been revised and replaced with TAH and TAqH (See Section 7.4).

4.4.1 OU5 Remedy Implementation and Status

The OU5 ROD was signed on February 1, 1995 (USAF, 1995b) and selected a remedial action that included the construction and operation of an engineered wetland remediation system (WRS), and natural attenuation and LUCs for the Beaver Pond wetland area. The major components of the selected remedy and current status of each is provided in Table 4-14.

Table 4-14

OU5 Remedy Implementation Status

Remedy Component	Brief Status
Approximately 3,000 cubic yards of fuel product-contaminated soil will be excavated from ST37 and treated at an on-base treatment facility to reduce contaminant concentrations below cleanup levels.	Completed: Excavated 1997, Treated 1999.

Table 4-14 (Continued)

Remedy Component	Brief Status
Natural attenuation will be relied upon to attain cleanup levels in the contaminated shallow aquifer and surface water at ST37, other than seep water, including the Beaver Pond wetland area.	Ongoing.
Groundwater, seep water, and surface water will initially be sampled on a quarterly basis. Sediment will be sampled annually. Results of the monitoring program will be assessed annually for at least the first five years to determine if cleanup levels have been achieved.	Ongoing. Groundwater natural attenuation is monitored by the Basewide Program.
Contaminated seep water in the western (i.e., Seeps 1, 2, and 3) and central (Seep 4) portion of OU5 will be passively drained using horizontally inserted extraction wells in the bluff. Contaminated seep water will flow to a constructed wetland, at the location of the "snowmelt pond" (Engineered Wetland).	Ongoing.
A layer of gravel was placed over the sediments in the "snowmelt pond" (Engineered Wetland) to isolate low levels of PCB contamination.	Completed 1997.
LUCs that prohibit use of the shallow aquifer will ensure that people will not be exposed to contaminated groundwater until cleanup levels are achieved.	Implemented July 1998.

All remedial actions are operational and functional. The WRS is operating as designed and is routinely maintained according to the O&M Manual (USAF, 1999). The WRS includes four seep collection areas that passively drain to three pump stations. Water collected in the pump stations is pumped to the Overland Flow Cell where it is aerated before entering the engineered wetland cell. Detailed information on the WRS design is contained in the *OU5 Design Analysis Report* (USAF, 1995c). The WRS has been operating as designed and monitoring has occurred (quarterly seep, influent, and effluent sampling) since October 1997.

Groundwater monitoring is continuing at OU5 and upgradient locations as part of the Basewide Groundwater Monitoring Program. Monitoring results are evaluated annually and the program is modified as appropriate to ensure the program remains comprehensive and protective. Figures C-6 and C-7 in Attachment C illustrate the status of the contamination found at key wells in OU5. In addition, Attachment C includes decision guides for monitoring well selection and analysis (Figure C-1) and monitoring well sampling frequency (Figure C-2). The annual number of wells and seeps sampled at OU5 since the previous five-year review is included in Table 4-15.

Table 4-15

Number of Wells and Seeps Sampled at OU5, 1998 to 2002

Year	Number of Wells Sampled	Number of Seeps Sampled
1998	20	4
1999	20	4
2000	20	4
2001	17	14
2002	33	11

Note: Newly identified seeps were discovered and added to the sampling program beginning in 2001.

The majority of the shallow aquifer discharges into wetlands adjacent to Ship Creek, the point of compliance, where the state surface water quality standards must be met. Monthly surface water monitoring of Ship Creek was accomplished from 1994 to 1996 to evaluate its condition and no evidence of COCs was found. Therefore, beginning in 1997, the sampling

frequency of Ship Creek was reduced to twice yearly in conjunction with OU5 groundwater sampling. LUCs have been established and are being maintained to prevent exposure until cleanup levels are attained (see Section 4.7).

4.4.2 OU5 Systems O&M

The WRS system operated more than 99 percent of the time in 2002. Annual technical reports, produced each year since system startup, provide detailed information regarding system monitoring, operation, and maintenance tasks that have been performed. Several practices are in place at the WRS to ensure continued operation of the system as designed. They include the following:

- An O&M manual (USAF, 1999) was developed to provide standard procedures to ensure protectiveness of the system. The manual also provides procedures for troubleshooting and sampling.
- The influent and effluent of the WRS and Beaver Pond are sampled quarterly. The resulting analytical data are reviewed and reported on a quarterly basis.
- Flow is monitored in the wetland cell to ensure proper residence time.
- Maintenance of the system includes daily, weekly, quarterly, and annual site visits and procedures. The system was installed with an autodialer, which automatically calls the operating team in the case of a power outage, pump failure, high water levels, etc. Daily maintenance includes responding to any calls made to the operator by the autodialer. Visual inspections of the system occur on a weekly basis. The inspections include visual checks of system components, water conditions, and any site conditions that may adversely affect operation of the system. Water in the pump stations, overland flow cell, and wetlands are checked for the presence of sheen or odor. Further, seep areas are checked for the presence of any new seeps, and contamination if new seeps are found.
- Typical maintenance tasks include pump maintenance, pump station and transport piping cleanout, and iron precipitate removal.

Annual system O&M costs include planning and management, operation and maintenance of the WRS, sampling, monitoring, reporting, and five-year reviews. Total costs for FY 1995 through FY 2003 are presented in Table 4-16.

Table 4-16

O&M Costs for OU5, FY 1995 through FY 2003

Fiscal Year	Wetland Remediation System Operation	Groundwater and Seep Monitoring	Land Use Controls Plan	Five-Year Review	Total Costs*
1995	--	$ 51,140	--	--	$ 51,000
1996	--	$ 38,007	--	--	$ 38,000
1997	--	$ 129,000	--	--	$ 129,000
1998	$ 53,827	$ 129,000	--	--	$ 183,000
1999	$ 203,275	$ 119,353	--	--	$ 323,000
2000	$ 225,317	$ 124,292	--	--	$ 350,000
2001	$ 208,986	$ 106,322	--	--	$ 315,000
2002	$ 212,485	$ 101,193	$ 1,792	$ 2,074	$ 317,000
2003	$ 286,530	$ 162,316	--	--	$ 449,000
Total Cost:					**$ 2,155,000**

*Total Costs are rounded to nearest $1,000.

4.5 Operable Unit 6

OU6 consists of three source areas located north of the Elmendorf Moraine (LF04, WP14, and SD15) and three source areas located south of Ship Creek (LF02, LF03, and SD73) (Figure 2, Attachment A). LF02, LF03, and LF04 are former landfills. LF04, which overlooks Knik Arm of Cook Inlet, was used as a surface dump from 1945 to 1957. Debris from the landfill frequently drifts down the bluff slope onto the beach.

WP14 and SD15 were POL sludge disposal pits and SD73 consisted of surface drains in a building once used as a rock-testing laboratory with a surface disposal area next to the building. Table 2-1 provides a brief summary of the chronology of events at OU6.

In FY 1996, source area SS19 was moved to OU6 from OU7 because it was the only source area remaining in OU7. During 1995, an expedited response action to remove the pesticide (dieldrin)-contaminated soil was completed at SS19. As a result of the successful completion of the response action, the agencies have agreed this source qualifies as NFA because the contaminated soils at SS19 have been satisfactorily removed and the residual risk is at an acceptable level. The 1997 ROD for OU6 documents the removal action and NFA designation.

Pre-ROD responses included the removal of an underground storage tank and petroleum-contaminated soils in the vicinity of the pump house building (State Program site PL81) in 1996. Although this is a state program site, the source is suspected to contribute to contamination at LF04. In addition, removal of surface debris was conducted throughout LF02 in the fall of 1996, and soil covers were constructed over three areas to minimize potential human exposure to lead contaminated soils in these areas.

Due to minimal contamination at LF03 and SD73, these sites were designated as NFA in the OU6 ROD (USAF, 1997a).

OU6 has been divided into OU6 North, which consists of source areas LF04, WP14, and SD15; and OU6 South, which consists of LF02 (as well as NFA sites LF03 and SD73). Specific RAOs were developed for each area at OU6.

For OU6 North, the RAOs are:

- Prevent the ingestion, dermal contact, and inhalation of vapors from the groundwater at LF04 South having benzene, toluene, ethylbenzene, 1,2-dichloroethane and methylene chloride in excess of MCLs and/or resulting in a cancer risk greater than 1.0×10^{-6} or Hazard Index greater than 1.
- Mitigate human dermal exposure, to the extent practicable, to landfill waste or debris at LF04 North/Beach.
- Mitigate exposure, to the extent practicable, of environmentally sensitive receptors to landfill waste in beach soils at LF04 North/Beach. Relevant exposure pathways for wildlife include incidental ingestion of contaminated soil, ingestion of contaminated vegetation, and ingestion of contaminated animals (e.g., insects and earthworms).
- Prevent the ingestion, dermal contact, and inhalation of vapors from the groundwater at WP14 having benzene, ethylbenzene, and toluene in excess of MCLs and/or resulting in a cancer risk greater than 1.0×10^{-6} or Hazard Index greater than 1.
- Prevent the domestic use of water in the perched aquifer at SD15, having benzene; ethylbenzene; toluene; 1,1,2,2-tetrachloroethane; 1,1,2-trichloroethane; 1,2-dichloroethane; and TCE in excess of MCLs and/or resulting in a cancer risk greater than 1.0×10^{-6} or Hazard Index greater than 1.

- Prevent the possible migration of contaminants from soils at SD15, having DRO, GRO, and BTEX concentrations exceeding ACM Level D.

For OU6 South (LF02), the RAOs are:

- Prevent the ingestion and dermal contact of water, and inhalation of vapors from groundwater while bathing, for water having 1,1,2,2,-tetrachloroethane in excess of cleanup levels or resulting in a cancer risk greater than 1×10^{-6}.
- Mitigate, to the extent practicable, human dermal exposure with lead contaminated shallow soils and exposed landfill waste or debris present on the landfill surface, and
- Preserve existing vegetation and ecological habitat to the extent practicable.

Table 4-17 summarizes the cleanup levels identified in the OU6 ROD, which are based on MCLs for groundwater and ACM Level D for soil contamination.

Table 4-17

Cleanup Levels at OU6

Chemical	ROD-Established Cleanup Level	Basis for Cleanup Level[1,2]
OU6--North		
Groundwater:		
Benzene	5 µg/L	MCL
Ethylbenzene	700 µg/L	MCL
Toluene	1,000 µg/L	MCL
1,1,2-Trichloroethane	5 µg/L	MCL
1,1,2,2-tetrachloroethane	--[a]	--
1,2-Dichloroethane	5 µg/L	MCL
Methylene chloride	5 µg/L	MCL
TCE	5 µg/L	MCL
Soils:		
GRO	1,000 mg/kg	ACM, Level D
DRO	2,000 mg/kg	ACM, Level D
BTEX	100 mg/kg	ACM, Level D
Exposed landfill debris	--	18 AAC 60.390
OU6--South		
Groundwater:		
1,1,2,2-tetrachloroethane	0.43 µg/L	Risk-based cleanup level
Soils:		
Lead	--[b]	--
Exposed landfill debris	--[b]	--

-- not applicable

[1]Basis for cleanup level is MCL, 40 CFR 141.61 for Federal MCLs, and 18 AAC 80.070 for State standards presented in the OU6 ROD.

[2]Basis for cleanup level is ACM, 18 AAC 78.315 presented in the OU6 ROD.

[a] Does not have an MCL; therefore there is no cleanup level. Cleanup will be considered complete when all other contaminants of concern meet MCLs.

[b]ROD does not specify cleanup levels because risk analysis resulted in hazard index below standards. A lead uptake/Biokinetic model was the basis for listing lead as a COC. For exposed landfill debris, Alaska Solid Waste Regulations 18 AAC 60.390 for landfill closure applies.

4.5.1 OU6 Remedy Implementation and Status

The OU6 ROD was signed on January 27, 1997. The major components of the selected remedy and current status of each is provided in Table 4-18.

Table 4-18

OU6 Remedy Implementation Status

Remedy Component	Status
Groundwater at LF02, LF04 (South), WP14, and SD15 will be included in the Basewide Monitoring Program. Results will be evaluated annually to determine contaminant migration and track the progress of contaminant degradation and dispersion.	Ongoing.
At LF04 (South) and WP14, recoverable quantities of free product found on top of the water table will be removed during groundwater monitoring events.	Ongoing.
Conduct annual debris removal on the beach at LF04 North/Beach.	Ongoing.
Groundwater in the perched aquifer at SD15 will be treated by a HVE process to remove fuel related contaminants and halogenated volatile organic compounds (VOCs). Free product will also be recovered using this process. Treated water will be reinjected into the subsurface beyond the boundary of the contaminated aquifer. Reinjected water will be regularly monitored to ensure it meets cleanup and risk requirements. Deep soils at SD15 will be actively treated through air stripping associated with the HVE process.	Ongoing.
Contaminated shallow soils at SD15 will be removed, treated by low-temperature thermal desorption, and backfilled.	Completed 1997.
Implement LUCs at LF02, LF04, WP14, and SD15 to prohibit the use of the shallow aquifer and/or designate the areas as "restrictive use area" to prohibit the construction of any sort of manned facility, such as an office building or residence.	Implemented August 1998 (September 1997 at LF02).
Landfill debris on top of or protruding from the surface at LF02 will be removed and a limited cover will be applied in three areas with elevated lead concentrations to eliminate the exposure pathway.	Completed October 1996.

The remedial design was completed and all of the selected remedies were started by October 1996. Because groundwater contaminant levels in the deep confined aquifer did not exceed regulatory cleanup levels or human health risk levels, remediation of the deep confined aquifer was not required. A discussion of the remediation status follows:

- OU6 Groundwater. Groundwater at LF02, LF04, WP14, and SD15 is currently monitored annually as part of the Basewide Groundwater Monitoring Program. The purpose for monitoring at OU6 is to assess contaminant migration and the timely reduction of contaminant concentrations by natural attenuation. Free product recovery during the summer months of June, July, August, and September is currently ongoing at LF04 (South) and WP14. Figure C-8 in Attachment C illustrates the status of the contamination found at key wells in OU6. In addition, Attachment C includes decision guides for monitoring well selection and analysis (Figure C-1) and monitoring well sampling frequency (Figure C-2). The number of wells and seeps sampled each year at OU6 since the previous five-year review is included in Table 4-19.

Table 4-19

Number of Wells and Seeps Sampled at OU6, 1998 to 2002

Year	Number of Wells Sampled	Number of Seeps Sampled
1998	22	0
1999	22	0
2000	20	0
2001	19	0
2002	15	8

- LF04 Soils. The selected remedy for the LF04 North/Beach soil is annual removal of beach debris. This effort has been conducted each summer since 1997. The annual removal of debris includes all material that has fallen onto the beach that can be reasonably collected for disposal, as well as debris on the bluff slope or other low-lying areas that can be accessed and removed without hazard. The following specific actions were taken in order to meet the RAOs outlined in the OU6 ROD for the LF04 beach:
  - The beach debris removal has occurred annually since 1997 and will continue annually for 25 more years, or as long as the landfill remains subject to erosion by tides. Debris collected has been disposed of in accordance with the National Oil and Hazardous Substances Pollution Contingency Plan – Off-Site Disposal Rule, 40 CFR 300.440.
  - LUCs have been established to limit access to soil and debris on the beach. Fencing was installed on the south end of LF04 to limit access through the Port of Anchorage and gates were installed on Elmendorf AFB access roads to limit access through Elmendorf AFB. Signs were installed stating that hazards exist at the site and access is not allowed.

Several studies, monitoring, and practices have been implemented to evaluate and ensure continued implementation and protectiveness of the selected remedy at LF04 (refer to Section 6.3.5.1 for a review of study results). These include:

- Completed the Erosion Monitoring Study, which documents site visit observations, erosion monitoring of the site, review of aerial photographs, and estimates an erosion rate (USAF, 2002a).
- Completed the Erosion Control Project, which included development and evaluation of seven alternatives to address erosion of the landfill (USAF, 2002a).
- Elmendorf recently completed an Operations and Management Plan for LF04 that makes provisions for extensive sampling every five years plus exploratory study of some specific areas of the bluff.
- Collected soil, sediment, and seep samples in December 2002 from the LF04 beach area to determine if contaminant concentrations have changed since the 1996 RI/FS in preparation for this five-year review.
- Inspections are conducted prior to annual beach debris removal to evaluate the volume of material to be removed and identification of items of concern such as hazardous substances, pollutants, contaminants, or ordnance and explosives.
- Periodic beach inspections are performed as required, typically after storm events, change in season, or following a report of a suspicious item. Trained personnel inspect items identified and properly dispose of items determined to be imminently hazardous or dangerous.

- Access control practices including (1) annual inspection and maintenance of fencing and signs, (2) patrols of the LF04 bluff area by Elmendorf Military Police, and (3) coordination with Port of Anchorage security to monitor and minimize access through the Port of Anchorage.

- SD15 Soils. The selected remedy for SD15 soils includes a combination of exposure reduction, contaminant removal, and contaminant treatment. During June 1996, four areas of fuel hydrocarbon-contaminated surface soils were excavated. The HVE system was designed and constructed in the fall of 1996. The HVE system was activated in December 1996 and has been in operation since that time.

  By December 2002, the HVE system at SD15 operated for a total of 27,199 hours. Over this six-year period the operation rate was 51.75%. About 312,254 gallons of water was extracted and seven pounds of VOCs were removed through the liquid phase and 10,086 pounds through the vapor phase. Only benzene and TCE remain above cleanup levels in OU6MW-17 and OU6MW-18. Only TCE currently exceeds the cleanup level at OU6MW-90. No other COCs remain above cleanup levels for groundwater at the site.

  Deep soil closure sampling was performed at HVE Wells 1302, 1303, and 1304 in the summer of 2002 to document the effectiveness of HVE at treating deep soils. Sampling at these locations demonstrated remediation was complete at HVE Well 1302 (also referred to as OU6MW-90) and at HVE Well 1304. Deep soil samples at HVE Well 1303 were all below cleanup levels with the exception of one sample from the 9-11 feet below ground surface (bgs) interval. Although this contamination is technically in "deep" soils, it is relatively shallow and in the same vicinity as documented shallow soil contamination.

  Shallow soil hydrocarbon contamination still exists at two distinct locations at the site. One of these is in an area just south of the HVE process building. Samples collected from this area (EHVE02-SB03C) in June 2002 indicated that remaining hydrocarbon contamination slightly exceeds the GRO cleanup level and is below remediation goals for all other COCs. The other area of shallow soil contamination exists near HVE Well 1303. Contamination remaining in this area was also verified with the June 2002 samples (EHVE02-SB1303C), which exceeded cleanup levels for DRO, GRO, and BTEX. All other shallow soils samples at this locality were below cleanup levels for all of the COCs.

  Soils with contamination above cleanup levels were sampled one year after system start up and every three years thereafter to evaluate reduction of contaminant concentrations. When two consecutive groundwater-monitoring events indicate all COCs are below cleanup levels, the HVE system will be shut off. Semi-annual monitoring will continue for one additional year, and subsurface soil samples will be collected. If levels are confirmed to be below cleanup levels one year after the system has been shut down, no further remedial action will be required. If contamination is present in any of the samples, the system will be restarted, or another remedial option will be considered.

LUCs have been established and are being maintained to prevent exposure until cleanup levels are attained (see Table 4-22).

4.5.2 OU6 Systems O&M

The SD15 HVE system is monitored and sampled on a regular basis to determine if the system is operating efficiently and to estimate the mass of contamination being removed from the subsurface. System performance is evaluated using historical data, liquid and vapor phase data, monitoring well data, and the periodic collection of subsurface soil data. Several practices are in place at SD15 to ensure continued operation of the system and to monitor progress. They include the following:

- An operations and maintenance manual (USAF, 1997b) was developed to provide standard procedures to ensure protectiveness of the system. The manual also provides procedures for troubleshooting and sampling.
- The effluent of the system is sampled monthly to verify that treated water being injected into the subsurface meets the cleanup and risk requirements specified in the ROD (State of Alaska Underground Injection Control Program standards).
- Sampling of the vapor phase at the discharge stack of the system is performed monthly to quantify the total amount of contamination removed through the vapor phase for the entire system. In addition, quarterly sampling of the vapor phase at each wellhead is performed to quantify the amount removed through the vapor phase at each well. As part of preparing the basewide air quality permit application in December 2000, the USAF completed an emissions inventory and it was determined that the HVE system is not a significant source. Stack emissions are considered negligible and do not present a threat to human health or the environment.
- Quarterly sampling of oil/water separator influent is conducted to determine the contaminant mass removed through the liquid phase.
- Groundwater samples are collected biannually to determine the degree of groundwater contamination reduction.
- Maintenance of the system includes weekly, quarterly, and annual procedures and visits. The system was installed with an Autodialer, which automatically calls the operating team in the case of a power outage, pump failure, high water levels, etc. Daily maintenance includes responding to any calls made to the operator by the Autodialer.
- Longer-term tasks include snow and ice removal, pump maintenance, and replacement of filters used to remove contamination from the vapor and fluid phases.

The treatment system at SD15 operated below its expected performance from June until October 2002. Continued overheating problems caused frequent shutdowns that also exhibited symptoms of electrical supply and controls problems. In November 2002, the system was disassembled in an effort to identify and correct the undiagnosed problems. In short, three main contributors were identified as problems:

- the vacuum pump had a cracked impeller,
- the radiator (aftercooler) for the system had plugged and was not cooling the system media properly, and
- the 50 horsepower motor "softstart" was locking into a run mode due to excessive heat build-up and therefore allowed the system to run when the temperature sensors were identifying an "over-temperature" condition.

The following corrective actions were taken:

- a new pump was installed,
- a new radiator was installed,

- a physical electrical contact was installed between the main power and motor softstart to prevent the system from locking into a "run" mode if the system overheated (allowing the temperature sensors to work as designed and installed), and
- various other maintenance items.

Following completion of this work, the treatment system at SD15 ran at 96.5 percent operational efficiency over a 5.5-month period after restart of the system.

In addition, a treatability study is currently being implemented (startup September 2003) to address remaining areas of relatively shallow soil contamination to determine if modifications to the HVE system will effectively treat these areas. The modifications incorporate soil-vapor-extraction (SVE) through the installation of two wells per location (4 wells total) that are incorporated into the existing HVE system piping. The wells were placed such that the radius of influence of the wells at each location should overlap to provide the maximum treatment area.

Annual system O&M costs include planning and management, operation and maintenance of the HVE system at SD15, LF04 beach sweeps and debris disposal, sampling, monitoring, reporting, and five-year reviews. Total costs for FY 1996 through FY 2003 are presented in Table 4-20.

Table 4-20

O&M Costs for OU6, FY 1996 through FY 2003

Fiscal Year	HVE System Operation	LF04 Beach Sweeps	Groundwater and Seep Monitoring	Land Use Controls Plan	Five-Year Review	Total Costs*
1996	--	$62,454	$152,029	--	--	$ 214,000
1997	$81,212	--	$123,000	--	--	$ 204,000
1998	--	$64,400	$117,500	--	--	$ 182,000
1999	$137,208	$69,475	$113,667	--	--	$ 320,000
2000	$130,920	$359,867‡	$400,034	--	--	$ 891,000
2001	$154,168	$82,000	$116,982	--	--	$ 353,000
2002	$171,270	$465,105†	$125,018	$9,931	$10,037	$ 781,000
2003	$31,000	--	$139,845	--	--	$ 171,000
Total Cost:						**$ 3,116,000**

*Total Costs are rounded to nearest $1,000.

‡ Costs for LF04 Beach Sweeps in FY 2000 is elevated due to oral history and erosion studies conducted for the site, in addition to the annual beach sweep.

† Costs for LF04 Beach Sweeps in FY 2002 included $380,000 for preparation of the Operations Management Plan, which included beach sweeps in 2003 as part of plan preparation.

4.6 SA100

SA100 is located at the Private Sector Financed Housing Site near the Boniface entrance to Elmendorf AFB. During a new utility excavation in June 2001, buried debris and suspected contaminated soil were discovered. Within two weeks, the site was designated as a CERCLA "time critical removal action" and site investigations began immediately followed by a removal action in August through September 2001. The site investigation included soil sampling that indicated elevated metals, VOCs, and petroleum contamination. The most conservative State of Alaska lead cleanup level of 400 mg/kg was used during the cleanup activities to delineate the limits of the excavation and characterize the soil removed from the site for disposal. The final soil cleanup levels are shown in Table 4-21.

Table 4-21

Cleanup Levels at SA100

Contaminant of Concern	Cleanup Level	Source of Requirement
Soil (mg/kg)		
DRO	250	18 AAC 75.341 Table B1 Method 2[1]
RRO	11,000	18 AAC 75.341 Table B1 Method 2[1]
Arsenic	16.2	Background[2]
Barium	214	Background[2]
Cadmium	3.03	Background[2]
Chromium	76.1	Background[2]
Mercury	0.23	Background[2]
Lead	400	Site-specific State cleanup level based on the most conservative residential land use.
Selenium	0.69	Background[2]
Silver	2.0	Background[2]

[1]The most stringent of the criteria listed in 18 AAC 75.341 Table B1 Method 2 under 40-inch zone

[2]Documented background levels in Elmendorf AFB soils and published in 1993.

4.6.1 SA100 Remedy Implementation and Status

Approximately 1,000 cubic yards of soil, 568 tons of debris, and 175 drums of uncontaminated soil were characterized and disposed appropriately. Due to lead concentrations, about 22 tons of soil were classified as hazardous waste and 114 tons of soil were classified as being above ADEC cleanup criteria but a non-hazardous material; both were transported to a RCRA-permitted facility in Idaho. Twenty-one confirmation soil samples confirmed that all metal concentrations above background levels and all petroleum-contaminated soils above regulatory criteria had been removed.

The USAF and EPA determined that because the conservative cleanup level of 400 mg/kg for lead was used, a site closure document as well as documentation in this five-year review would be sufficient to demonstrate concurrence for site closure and preparation of a ROD for SA100 would be unnecessary. Because agencies concur that no further response action is necessary, the USAF considers SA100 closed.

4.7 Land Use Controls

Elmendorf AFB has established LUCs as part of each ROD, except OU3. OU3 is closed and is not required to be included in this five-year review. The term "institutional controls" is used in the OU RODs, however the USAF prefers the term "land use controls." For the purposes of this report, the terms "institutional controls" and "land use controls" are used synonymously. LUCs were established for OUs 1, 2, 4, 5, and 6 in their respective OU RODs as a component of their selected remedies, as mentioned in the previous sections. These LUCs were established at Elmendorf AFB to prevent exposure to contaminated media, and they include restrictions on the use of the shallow aquifer south of the Elmendorf Moraine, limitations on the types of buildings at specific areas (primarily occupancy limitations), and designations of specific areas for recreational use only. In some cases, LUCs have been expanded beyond the requirement of the RODs for convenience. For example, there is no requirement for a basewide restriction on the use of the shallow aquifer; however, this restriction has been made to be generic to the Outwash Plain for convenience and to avoid confusion as to which building(s) can/cannot use the water.

The LUCs have been incorporated into a Land Use Controls Management Plan (USAF, 2003a) and are also outlined in the Base General (Comprehensive) Plan (USAF, 1997c). A recent

internal audit that was conducted as part of preparation of the Land Use Controls Management Plan indicated that the program is effective and no construction has occurred on Elmendorf AFB that would be inconsistent with the established land use controls. The Elmendorf Environmental Protection Committee is responsible for overseeing compliance with these LUCs. The implementation and effectiveness of these LUCs are reviewed at least annually by the Elmendorf Environmental Flight and any proposed changes affecting these controls are forwarded to EPA and ADEC for review. A line item in Table 2-1 shows the dates that LUCs were implemented at each OU.

The previous sections, applicable to each OU, describe LUCs implemented as part of the RODs. Post-ROD changes relating to LUCs have occurred for OUs 1 and 2 and are as follows:

- The OU1 ROD specified zoning of the affected areas for "outdoor/recreational use." However, local zoning codes do not apply to Elmendorf AFB. In lieu of zoning, LUCs were established and are to be maintained until cleanup levels are achieved. The LUC for OU1 designates the area as "restricted use area" authorized for recreational use and construction of unmanned facilities. The construction of manned facilities is prohibited.
- To resolve the conflict presented with the differing zoning designations specified in the OU2 ROD, the EPA, ADEC, and USAF agreed to interpret the ROD as allowing outdoor/recreational use and unmanned industrial use.

Table 4-22 describes the LUCs adopted at Elmendorf AFB to ensure compliance with ROD-specified LUCs at each OU.

In addition to the site-specific restrictions provided in Table 4-22, Elmendorf AFB has implemented a restriction on the use of groundwater from the shallow aquifer south of the Elmendorf Moraine; this area is known as the Outwash Plain. Use of Elmendorf AFB's shallow aquifer in the Outwash Plain for any purpose including, but not limited to, drinking, irrigation, fire control, dust control, or any other activity south of the Elmendorf Moraine is strictly prohibited. It is understood that portions of the shallow aquifer are contaminated and may pose a health risk.

Table 4-22

Site-Specific Land Use Controls, Elmendorf AFB

OU (Site)	Land Use Control (LUC) Description	Expected Year of LUC Expiration
1	"Restricted Use Area" designated for recreational use and construction of unmanned facilities (such as parking lots, storage buildings, etc.). The construction of manned facilities (such as office buildings or residential structures) is strictly prohibited. Excavation affecting the integrity and function of the landfill caps, or impacting the shallow groundwater table is not allowed.	2004
2 (ST41)	"Restricted Use Area" designated for recreational use of the parcel (such as cross-country skiing, etc.) and construction of unmanned facilities (such as parking lots, storage buildings, or taxiways). The construction of manned facilities (such as office buildings or residential structures) is strictly prohibited. As long as hazardous substances remain on this site at levels that preclude unrestricted use, groundwater development and the use of the groundwater at this site for any purpose including, but not limited to, drinking, irrigation, fire control, dust control or any other activity is prohibited.	2016
3	No site-specific LUCs are in effect at OU3.	
4	"Airfield Use Area" designated for aircraft O&M, which include active and inactive runways, taxiways, and parking aprons for aircraft. The establishment of residential development of the areas is strictly prohibited.	2006
5	No site-specific LUCs are in effect at OU5.	
6 (LF02)	"Restricted Use Area" designated for recreational use of the parcel (such as cross-country skiing, etc.) and construction of unmanned facilities (such as parking lots, storage buildings, or taxiways). The construction of manned facilities (such as office buildings or residential structures) is strictly prohibited. Drilling into the shallow aquifer is restricted by the Base Comprehensive Plan. As a former landfill, this designation will remain indefinitely.	Indefinite
6 (LF03)	"Restricted Use Area" designated for recreational use of the parcel (such as cross-country skiing, etc.) and construction of unmanned facilities (such as parking lots, storage buildings, or taxiways). The construction of any sort of manned facilities (such as office buildings or residential structures) is strictly prohibited. As a former landfill, this designation will remain indefinitely. This site is also permanently included in the "accident potential zone" which further restricts the construction of any above ground facilities at this location.	Indefinite

Table 4-22 (Continued)

OU (Site)	Land Use Control (LUC) Description	Expected Year of LUC Expiration
6 (LF04)	"Restricted Use Area" designated for recreational use of the parcel (such as cross-country skiing, etc.) and construction of unmanned facilities (such as parking lots, storage buildings, or taxiways). The construction of any sort of manned facilities (such as office buildings or residential structures) is strictly prohibited. As a former landfill, this designation will remain indefinitely. The use of contaminated groundwater throughout LF04 for any purpose including, but not limited to, drinking, irrigation, fire control, dust control or any other activity is prohibited. Drilling into the shallow aquifer is also restricted.	Indefinite
6 (SD15)	Land use controls restrict access to contaminated groundwater throughout the site. Installation of wells in the contaminated plume for residential, industrial, or agricultural use will be prohibited until cleanup levels have been achieved.	
6 (WP14)	"Restricted Use Area" designated for recreational use of the parcel (such as cross-country skiing, etc.) and construction of unmanned facilities (such as parking lots, storage buildings, or taxiways). The construction of any sort of manned facilities (such as office buildings or residential structures) is strictly prohibited. As a former landfill, this designation will remain indefinitely. Land use controls restrict access to contaminated groundwater throughout the site. Installation of wells in the contaminated plume for residential, industrial, or agricultural use will be prohibited until cleanup levels have been achieved.	2011
(SA100)	No site-specific LUCs are in effect at SA100.	

Section 5.0
PROGRESS SINCE LAST FIVE-YEAR REVIEW

No areas of non-compliance were identified during the first five-year review in 1998. At that time, all remedies were protective of human health and the environment and LUCs adequately prevented potential exposure to contaminants present in soil and the shallow aquifer. No recommendations for follow-up actions were made during the 1998 review.

The remedial systems were operating and functioning as designed and no modifications were required. Since 1998, contamination at OUs 1, 2, 4, 5, and 6 has decreased and the remedies continue to protect human health and the environment—as long as LUCs are in place. Contamination remains above levels that allow for unlimited use and unrestricted exposure at OUs 1, 2, 4, 5, and 6.

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Section 6.0
FIVE-YEAR REVIEW PROCESS

The guidelines outlined in EPA OSWER publication number 9355.7-03B-P (EPA, 2001a) were used to guide the review process.

In conducting this five-year review, the project team, consisting of the USAF, ADEC, and EPA, reviewed and evaluated the ROD requirements, work that has been done to satisfy those requirements, current and past monitoring data, current status of the remedies, and physical condition of the sites. This included site inspections of each OU where action has been performed or is in progress. Review of most of the OUs was done concurrent with preparation of OU annual summary reports. Those reports contain more details of the remedial actions performed for each OU, monitoring data, and evaluation of data trends and progress toward cleanup levels. An individual five-year review document was then drafted for each separate area or OU, the Basewide Groundwater Monitoring Program, and LUCs and reviewed and finalized internally with input from the EPA and ADEC. The overall Elmendorf Five-Year Review report was then compiled using these individual documents (or feeder documents), and then drafted and subjected to a series of peer and agency reviews.

6.1 Administrative Components

Interested parties, including ADEC and EPA were notified of the start of the five-year review process during a kickoff meeting held on January 31, 2003. The Community Environmental Board (CEB), formerly known as the Restoration Advisory Board, was notified that the review was forthcoming at their October 2002 meeting and again briefed during a meeting held in April 2003.

The five-year review team consisted of individuals from Environmental Restoration (3 CES/CEVR), Public Affairs (3 WG/PA), 11th Air Force Judge Advocate office (11 AF/JACE), EPA, and ADEC. Technical support was provided by support contractors to 3 CES/CEVR that had conducted recent O&M activities associated with the remedies at each site. Therefore, in addition to USAF personnel, these O&M site managers and staff participated in site inspections and interviews. Documentation of the inspections is located in Attachment D. Interview documentation is included in Attachment E.

The schedule of this five-year review extended through August 30, 2003 and was established during the January meeting and consisted of the following components:

- Individual 5-year Review Feeder Documents, which included:
  - Document Reviews
  - Data Reviews
  - Site Inspections
- Community Notification and Involvement;
- Local Interviews; and
- Basewide Five-Year Review Report Development and Reviews.

6.2 Community Notification and Involvement

The community was given opportunity to have input on the five-year review and the project team briefed the Elmendorf CEB on the draft five-year review document and its findings. The draft document was sent to all CEB members. The general public was notified of the opportunity to provide input through a fact sheet mailed on June 9, 2003. In addition, public notices were placed in the Anchorage Daily News on June 9, 12, and 15, 2003 as well as in the

Eagle River Star for one week starting on June 12, 2003 (re-run with corrections on June 26, 2003).

The public comments and input were accepted until July 29, 2003 so that they could be addressed in the final document. Following agency signature, the final document and a second fact sheet describing the findings of the review will be distributed (scheduled for January 2004).

6.3 Document and Data Review, Site Inspections, and Interviews

The RODs associated with each OU were reviewed to identify RAOs, to be considereds (TBCs), contaminants of potential concern (COPCs), COCs, and cleanup levels. The individual five-year review feeder documents and closure reports as well as quarterly and annual reports were reviewed to evaluate data trends, highlighted in the following subsections. In addition, the document and data review was used to prepare the technical assessment (Section 7), and identify any potential issues, (Section 8), and recommendations or follow-up actions (Section 9). Refer to the OU-specific annual reports for specific analytical results. The technical assessment in Section 7 includes an evaluation of changes to standards, newly promulgated standards, TBCs, and new toxicity information.

In this section, the performance of each selected remedy was evaluated using historical and current monitoring data. Trends in COCs for which ARARs were established in each ROD were evaluated to ensure that the associated selected remedy is performing as designed. In addition, all recent available analytical data (i.e., 2002 results) were screened to determine if any contaminants are currently present above state (e.g., 18 AAC 70, 18 AAC 75, 18 AAC 80) or federal (e.g., 40 CFR 131, 40 CFR 141) cleanup levels.

In addition, the USAF monitors the progress of natural attenuation as part of the Basewide Groundwater Monitoring Program using Air Force Center for Environmental Excellence (AFCEE) and EPA guidance. For fuels, the *Technical Protocol for Implementing Intrinsic Remediation with Long-Term Monitoring for Natural Attenuation of Fuel Contamination Dissolved in Groundwater* (Wiedimeier, 1999) was followed. For chlorinated solvents, the *Technical Protocol for Evaluating Natural Attenuation of Chlorinated Solvents in Ground Water* (EPA, 1998) was followed. These documents provide a detailed overview of biodegradation of fuels and chlorinated solvents and methods for qualifying and quantifying the evidence for natural attenuation.

The OU project managers, site manager, or O&M staff performed site inspections. OU Project Managers (the O&M site managers) and O&M staff for these sites were also interviewed. Site inspection checklists are located in Attachment D. Interview documentation is included in Attachment E.

For LUCs, various base organizations involved with LUC management were interviewed and their programs evaluated to develop an overall assessment of the effectiveness of LUC management at Elmendorf AFB. Numerous documents were also reviewed. A LUC interview form was developed and used for all interviews. The following bullets describe the LUC review process:

- Organizations interviewed during the five-year LUC review included base development and planning, utilities, real estate, privatization, environmental planning, and legal personnel.
- Interview items included a description of the organization's role in LUC management processes, their understanding of the LUC management processes in which they are involved, their opinion as to whether the processes are effective, opportunities for

improvement, instances where LUCs have been violated, and recommended changes to the processes.

- Documents reviewed include OU RODs, remedial action reports, the Elmendorf AFB General Plan, Tab D-6 (Constraints and Opportunities Map), the previous Five-Year Review report (USAF, 1998a), and the environmental condition of property maps.

6.3.1 Operable Unit 1

The remedy at OU1 is natural attenuation and LUCs. Recent data trends and the presence of daughter products in OU1 groundwater monitoring wells demonstrate that TCE is degrading and achievement of cleanup levels is likely within the timeframe predicted in the ROD. Manganese has been below cleanup levels at all locations in OU1 since 2001. Sites LF05, LF07, LF13, and OT56 have all met cleanup levels for all COCs. Only one well, LF59-MW-03, in Site LF59 remains above the ROD-established remedial action level for TCE.

The OU1 groundwater-sampling suite in 2002 included several analytes that were used to evaluate natural attenuation and VOC levels. The entire 2002 analytical dataset was reviewed to determine whether any chemicals, including target COCs as well as all associated chemicals in the analytical suite, were present at concentrations above current state or federal cleanup levels. This review determined that the maximum detected concentration of 1,1,2,2-tetrachloroethane in 2002 was 18 µg/L, which is above the ADEC groundwater cleanup level of 4 µg/L in well LF59-MW-03 (there is no federal cleanup level). This is the same well in which TCE was found above the cleanup level. 1,1,2,2,-tetrachloroethane was not established as a COC in the OU1 ROD because the risk assessment determined that the risk associated with the compound was within EPA's acceptable risk management range. An evaluation of the effects of this finding on remedy protectiveness will be discussed further in Section 7.1. No other analytes were detected above regulatory cleanup levels at OU1.

A site inspection and interview were performed at OU1, by O&M staff, on May 16, 2003. Access controls, LUCs, and monitoring wells were inspected. Access controls and LUCs appeared adequate: signs at the entrance gate appeared in good condition and no vandalism was evident. Inspection of the monitoring wells revealed all wells were in good working condition, properly located and locked, and spare parts were readily available. The wells are routinely sampled, monitoring data is submitted on time and is of acceptable quality. The site inspection checklist, included in Appendix D, indicates that a landfill cap was being placed at the time of the inspection. This refers to the Elmendorf AFB Municipal Solid Waste Landfill, which is being capped according to a State agreement and the *Municipal Solid Waste Landfill Closure Plan* (USAF, 1996a). Although this is not an action that is required by the ROD, the landfill cap is expected to result in diverting a large portion of storm water from infiltrating into the landfill, thereby limiting leachate migration and associated contaminants to groundwater in OU1.

6.3.2 Operable Unit 2

The selected remedy at OU2 is source removal (completed), operation of a free product recovery system (completed), natural attenuation of contaminants in groundwater (ongoing), and LUCs. The free product recovery system operated as designed and was shut down in April 1999, after no recoverable quantities of free product were observed for over a year (refer to Section 4.2.1). Since then, hand-bailing methods have been used regularly to recover remaining small quantities of floating free product (at wells with more than 0.1 foot thickness). The 2002 annual report for the Basewide Groundwater Monitoring Program indicated that the method of hand-bailing the remaining free product has had little observed effect (USAF, 2002b).

Groundwater and surface water data have verified that natural attenuation is occurring at ST41. Two hydrocarbon plumes exist in groundwater at ST41 and are separated by a groundwater divide (see Figure C-4, Attachment C). One plume is moving northwest while the

second is moving southeast. Both are from the same source. Groundwater and surface water data collected from 1996 through 2002 have verified that natural attenuation is occurring in both plumes at ST41. For example, maximum benzene concentrations reported in the north plume (well ST41-28) decreased from 737 µg/L to 270 µg/L between 1996 and 2002. In the southern plume, maximum benzene concentrations (well ST41-16) decreased from 14,500 µg/L to 13,000 µg/L during this period.

Recent sampling results show that BTEX concentrations in the southern plume may not be decreasing as quickly as predicted in the 2000 groundwater modeling report (USAF, 2001). It appears that the 2000 model may have overestimated the amount of contaminated source material that was removed during the initial remedial action. While BTEX concentrations in most monitoring wells appear to follow or even exceed reductions predicted by the revised year 2000 model, concentrations in one well in the southern plume show BTEX concentrations several times greater than the predicted concentrations. Well ST41-16 had BTEX levels of 32,400 µg/L while predicted BTEX concentrations were between 1,000 and 5,000 µg/L. Because current BTEX concentrations in part of the southern plume exceed predicted concentrations, it is unclear whether BTEX concentrations will meet cleanup levels in all wells by the predicted cleanup date of 2016 stated in the OU2 ROD. However, as illustrated on Figure C-4 in Attachment C, this plume appears to be shrinking over time and does not appear to be migrating from the site.

In 2002, groundwater samples at OU2 were analyzed for VOCs and the analytical data were reviewed to determine if any chemicals, including those not regularly monitored as part of ROD requirements, were present at concentrations above current state or federal cleanup levels. Benzene, ethylbenzene, and toluene were found above cleanup levels. All of these compounds are ROD-specified COCs and are regularly monitored as part of the remedy.

Site inspection and interviews performed at ST41 on May 16, 2003 revealed that LUCs and monitoring wells at OU2 appear to be adequate: signs at the entrance gate appeared in good condition, inspection of the monitoring wells revealed all wells were in good working condition, properly located and locked, and spare parts were readily available. The wells are routinely sampled, monitoring data is submitted on time and is of acceptable quality.

6.3.3 Operable Unit 4

The selected remedy at OU4 is bioventing of deep soils at three locations, natural attenuation of contaminants in groundwater, and LUCs. The success of the bioventing system is evidenced by monitoring which shows that COC concentrations at sites SS10, FT23, and SD25 have decreased significantly over the five years the bioventing systems have been in operation. A status of soil monitoring results are summarized below:

- SS10 Soils: TVH concentrations in soil gas testing results in 2001 indicate that low levels of petroleum hydrocarbons are still present in the subsurface. However, the in-situ respiration testing results indicated that bioventing continues to enhance hydrocarbon degradation.
- FT23 Soils: As indicated in Section 4.3.1, the blower at FTA-2 was shut down in 2000 after 1999 sampling showed that cleanup levels had been met. In 1999, the original area treated by FTA-1 had also met cleanup levels; however, the blower at FTA-1 continues to operate because the system was expanded in 2002 to address contamination that was identified at an area that was not included in the original treatability study (soil boring SB-64).

  A revised cleanup date for FT23 has not been established for the new area of contamination that was identified during the 1999 sampling. The sample (SB-64) exhibited contamination above the cleanup levels from the soil horizon immediately above the water table. Based upon the depth of contamination in the soil boring and the depth to groundwater at FT23 (36 - 44 feet bgs), it appears that contaminated groundwater may be spreading contamination in the

smear zone above the water table and in saturated soil at FT23. Groundwater appears to be re-contaminating subsurface soil in the smear zone at the groundwater interface. Although the bioventing system may slightly enhance biodegradation in this case, it is not designed to remediate saturated soils. Therefore, it is unlikely that soil cleanup levels will be met until groundwater is further remediated and constant recontamination of these soils subsides. The groundwater monitoring and LUCs will ensure protectiveness in the interim.

- SD25 Soils: As detailed in Section 4.3.1, closure sampling conducted in 1999 indicated cleanup levels had been achieved for DRO, GRO and total BTEX, but cleanup levels were not met for benzene. Follow-on closure sampling in July 2002 documents that degradation of benzene has occurred and remediation at SD25 is complete (USAF, 2002d). Annual reports from 1997 to the present provide analytical data collected from the bioventing systems.

Analysis of trends in groundwater COC concentrations at OU4 is as follows:

- OU4 East Plume:
  - TCE concentrations in this plume are approximately half of the concentration levels of 1993. The ROD predicted that the groundwater cleanup level would be reached by is 2008. Although natural attenuation is occurring, it is likely that the cleanup duration may exceed ROD specifications.
- OU4 West Area:
  - FTA Plume (OU4 FT23): Benzene remediation appears to be on track with the cleanup level to be reached by 2008. The chlorinated compounds found at OU4, however, are degrading more slowly than predicted by the groundwater models. Tetrachloroethene, TCE, and 1,2- dichloroethene may not reach cleanup levels by 2008.
  - OU4 West Plumes at wells OU4W-08 and OU4W-04: Remediation appears to be on track for ethylbenzene and toluene; however, remediation of benzene may take longer than specified in the ROD.

In 2002, groundwater samples at OU4 were analyzed for natural attenuation parameters, VOCs, GRO, and DRO. The analytical data were reviewed to determine if any chemicals, other than COCs, were present at concentrations above current state or federal cleanup levels. GRO and DRO, neither of which is included in the OU4 ROD chemical-specific ARARs for groundwater, were both found above ADEC groundwater cleanup levels. No federal cleanup levels exist for GRO and DRO in groundwater. An evaluation of the effects of this finding on remedy protectiveness will be discussed further in Section 7.3.

Site inspections at OU4 reveal that bioventing systems and monitoring wells are in good condition.

6.3.4 Operable Unit 5

The selected remedy at OU5 includes source removal (completed), seep water containment and treatment (ongoing), natural attenuation of contaminants in groundwater and surface water (ongoing), and LUCs. The point of compliance for the WRS is Ship Creek. To date, no contaminants have been detected in Ship Creek above cleanup levels. To provide additional protection to Ship Creek, the effluent of the WRS and Beaver Pond are also sampled. All effluent monitoring results from the WRS and Beaver Pond have been below cleanup levels.

Although the seeps currently captured are being effectively remediated, additional seeps (Seeps 9, 10, and 11) have been discovered which contain TCE in excess of cleanup levels. The USAF plans to incorporate these seeps into the WRS for treatment, as recommended in Section 9.

The source and extent of this TCE has not been adequately characterized and the potential exists for increased levels of TCE to discharge to surface water. In addition, the USAF has initiated further investigation into the suspected source and extent of the Kenney Ave Plume, where elevated TCE contamination has been identified (49 µg/L in well 403-MW-01) and modeling is scheduled for later this year.

Groundwater and seep sampling activities show that contamination is not migrating off-site as evidenced by consistent non-detect levels at the effluent of the WRS and Beaver Pond. Groundwater monitoring parameters indicate a high level of attenuation of fuels. Benzene levels throughout OU5 are generally below the cleanup level with the exception of Seep 2, which has a fluctuating trend at concentrations above the cleanup level. Although the presence of microbes that degrade TCE have been identified, a lack of an adequate carbon source appears to slow the rate of TCE remediation in some plumes (i.e., influent of Beaver Pond and Seeps 9, 10, and 11). Data trends indicate that TCE attenuation is occurring at rates slower than predicted in the OU5 model (USAF, 1994c) and TCE at OU5 may not reach cleanup levels by 2026 as specified by the OU5 ROD.

Modeling of the shallow aquifer was conducted in 1994, 1997, and the spring of 1998 to evaluate contaminant migration and the potential for impacts to downgradient receptors. Modeling concluded that the contaminant plumes are not migrating far from the source areas or reaching downgradient receptors. Results of this modeling are currently under reevaluation.

The OU5 groundwater sampling suite in 2002 included several analytes that were used to evaluate natural attenuation as well as VOC levels. The analytical data were reviewed to determine whether any compounds, including those not regularly monitored as part of ROD requirements, were present at concentrations above current state or federal cleanup levels. This review found 1,1,2,2-tetrachloroethane was above the newly promulgated ADEC groundwater cleanup level of 4 µg/L in wells GW-4A (4.7 µg/L) and OU5MW-08 (5.4 µg/L). No federal cleanup level exists for this chemical in groundwater. However, the sample results for the effluent from the Beaver Pond have been non-detect for 1,1,2,2-tetrachloroethane, which indicates that the remedy is functioning as intended and the remedy continues to be protective at the point of compliance located downgradient of the Beaver Pond (Ship Creek). In addition, tetrachloroethene was found above the ADEC groundwater cleanup level and the federal drinking water standard of 5 µg/L at well OU3MW-11 at a concentration of 6.2 µg/L. Neither tetrachloroethene nor 1,1,2,2,-tetrachloroethane was established as a chemical-specific cleanup level in the OU5 ROD because the risk assessment determined that the risks associated with the compounds were within EPA's acceptable risk management range. An evaluation of the effects of these findings on remedy protectiveness will be discussed further in Section 7.4. No other analytes sampled in 2002 were detected above regulatory standards at OU5.

Although sediment sampling has occurred annually since system startup, the intent of the cleanup level established in the ROD was to confirm cleanup of fuel-contaminated soils at ST37. Because several years of data have shown non-detect result for fuels, sediment samples will no longer be collected at OU5 starting in 2004, pending regulatory approval.

The site inspection and interview conducted on February 11, 2003 revealed that LUCs and monitoring wells at OU5 appear to be adequate; monitoring seep sampling pipes and wells were in good working condition, properly located and locked; the WRS system, overland flow cell, pipes, pumps, and associated controls appeared to be in good working order, and spare parts were readily available. The influent, effluent, seeps, and wells are routinely sampled, monitoring data is submitted on time and is of acceptable quality.

6.3.5 Operable Unit 6

The selected remedy at areas within OU6 includes natural attenuation of contaminants in groundwater (ongoing), annual beach debris removal (ongoing), landfill surface debris removal and cover application (complete), and groundwater treatment via HVE (ongoing).

A review of Basewide Groundwater Monitoring data trends in COCs in OU6 led to the following conclusions:

- LF04 South /WP14: Cleanup levels in the ROD were predicted to be complete by 2010. This timeframe is not likely to be met at either source area due to free product and groundwater contamination that is thought to have originated at PL81 (a State Program Site, not included in OU6). A performance-based contract is planned for 2004 through 2006 to treat contaminated soil in the vadose zone at PL81 to meet ADEC cleanup levels using a technology chosen by the contractor. The project will be designed to eliminate or decrease the suspected source of the POL-contamination, possibly through soil excavation, bioventing, or a combination of both of these remediation techniques.

- The OU6 groundwater sampling suite in 2002 included VOCs, DRO, GRO and several analytes that were used to evaluate natural attenuation. The analytical data were reviewed to determine whether any chemicals, including those not regularly monitored as part of ROD requirements, were present at concentrations above current state or federal cleanup levels. GRO and DRO, neither of which is included in OU6 chemical-specific ARARs for groundwater, were both found above ADEC groundwater cleanup levels. No federal cleanup levels exist for GRO and DRO in groundwater. An evaluation of the effects of this finding on remedy protectiveness will be discussed further in Section 7.5.

6.3.5.1 LF04 Data Review

A total of 216 tons of debris has been removed from LF04. Since the previous five-year review in 1998, approximately 118 tons of debris have been removed, consisting of: 108 tons of non-hazardous solid waste, 10 tons of recyclable material, and minimal hazardous waste (In 2001, one 55-gallon drum contained heavy oil that exceeded RCRA TCLP for heavy metals).

Maximum detected contaminant levels measured at LF04 in December 2002 were compared to maximum levels measured during the 1996 RI/FS to determine if contaminant concentrations had changed. December 2002 concentrations were also compared to criteria promulgated and TBCs published since the ROD was signed.

In general, contamination levels measured in 2002 were less than or equal to contamination levels measured during the 1996 RI/FS. Of those contaminants that increased in concentration, only cadmium and total tetrachlorodibenzofuran (TCDF) (in soil), and chromium (in sediment) exceed current available state or federal cleanup levels. Elmendorf AFB soil contains background concentrations of cadmium and chromium that likely contributed to the detected concentrations. Total TCDF concentration increased by 50 percent in only one out of nine samples and exceeded the federal cleanup level in two out of nine samples. Additionally, contaminants in soil and sediment samples collected in December 2002 did not exceed the state ACM criteria identified at the time of the ROD. Of the dioxins, total tetrachlorodibenzo-p-dioxin (TCDD), total pentachlorodibenzo-p-dioxin (PeCDD), total hexachlorodibenzo-p-dioxin (HxCDD), total heptachlorodibenzo-p-dioxin (HpCDD), total TCDF, 2,3,4,7,8-perchlorodibenzofuran (PeCDF), total PeCDF, and total hexachlorodibenzofuran concentrations exceed the EPA Region 9 criteria. However, with one exception (Total TCDF), all dioxin compounds detected in the 1996 RI/FS were measured at significantly lower concentrations in the December 2002 sampling event. Total TCDF increase was approximately 50 percent. The 1996 RI/FS did not contain results or risk-based concentrations (RBCs) for all dioxin compounds

detected in the December 2002 sampling event. This may be attributed to the more sensitive dioxin analytical method associated with the 2002 data, and not due to an increase in specific dioxin compound concentrations. In light of the significant reduction in the maximum concentrations measured for the majority of dioxin compounds, the overall risk has been reduced, and the remedy remains protective. The COC cleanup levels specified in the ROD are still appropriate and protective when compared to current cleanup levels.

An Erosion Monitoring Study completed at LF04 documents site visit observations, erosion monitoring of the site, and review of aerial photographs (USAF, 2002a). Based on this information, an erosion rate for the last 15 years was estimated at three feet per year. Using this average rate and assuming that environmental conditions remain the same, the estimated period remaining for the landfill to erode is 200 years. The quantity of debris removed from 1998 to 2002 does not vary significantly from year to year, averaging 24 tons per year. The rate of erosion does not appear to be increasing.

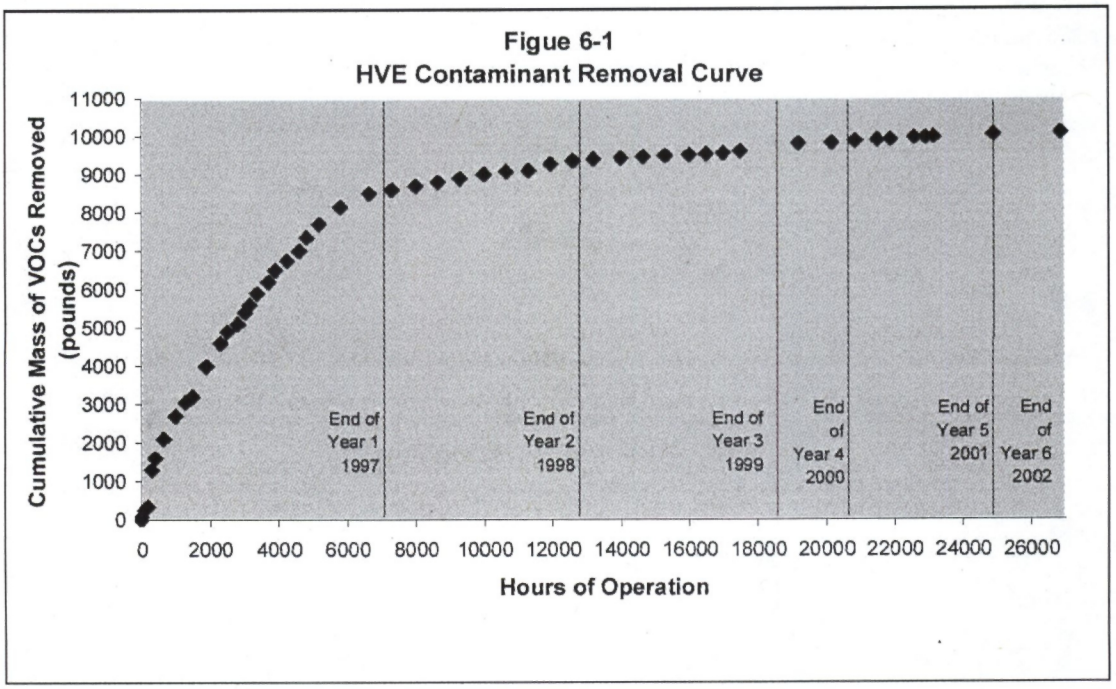
An erosion control project, conducted as part of the five-year review fact-finding process, included development and evaluation of seven alternatives to address erosion of the landfill (USAF, 2002a). The alternatives and associated cost estimates include: 1) minimal shoreline protection with quarry rock ($33.9 Million); 2) port expansion ($421.3 Million); 3) bluff lay-back with landfill removal ($333.4 Million); 4) sheet pile retaining wall ($7.4 Million); 5) above-bluff drainage ($440,300); 6) beach filtering ($17.8 Million); and 7) landfill removal ($39.3 Million). Based upon the costs of each of these alternatives and the finding that contamination levels measured in 2002 were generally less than or equal to contamination levels measured during the 1996 RI/FS, with the few exceptions mentioned previously, the annual beach sweep remains the most practicable remedy for LF04.

Elmendorf recently completed an Operations and Management Plan for LF04. The plan makes provisions for extensive sampling every five years plus exploratory study of some specific areas of the bluff. Earlier studies indicate that a few limited areas of the bluff, where concentrations of landfill waste exist (i.e., disposal trenches) may be responsible for most of the beach contamination. Data collected over the next five years after implementation of the Operations and Management Plan should determine if application of a limited treatment alternative to these high concentration areas would be beneficial and cost effective.

A site inspection was performed at LF04 during the December 2002 sampling event. No significant problems were identified. Documentation of the site inspection is located in Attachment D.

6.3.5.2 SD15 Data Review

The HVE system at SD15 has successfully remediated a large portion of the contamination, with the largest portion removed during the first few years. As Figure 6-1 illustrates, the contaminant removal rate was at its peak during the first year of operation and the rate has since declined significantly. This asymptotic trend suggests that active remediation is approaching steady-state conditions and the HVE system is reaching its performance capacity (USAF, 2003d).



The average operational rate during 1997 through 2001 was 56.6 percent. During the calendar year 2002 the HVE system was operational for approximately 26.1 percent of the time due to shutdowns caused by overheating since June 2002. A complete overhaul of the HVE system was accomplished during November and December 2002. Since the overhaul, the operational rate has been 96 percent through May 2003. This increased operational rate is expected to continue and should result in reducing some additional contaminants. However, as it is currently configured, the HVE system isn't designed to remove very low levels of contaminants and it is expected that groundwater cleanup levels may take longer to achieve than anticipated.

Shallow soil contamination still remains at two distinct locations at SD15. The first location is just south of the HVE Process Building where GRO slightly exceeds the cleanup level. The second location is near HVE Well W-1303 with DRO, GRO, and BTEX above the cleanup level. Deep soil contamination remains at only one location. GRO contamination found at HVE Well W-1303 is localized and found just below shallow soils, at the 9-11 feet bgs interval only. A treatability study is currently being implemented (startup in September 2003) to address these relatively shallow soil locations to determine if modifications to the HVE system, which incorporates SVE (see Section 4.5.2), will effectively treat these areas.

6.3.6 SA100

Document and data review for SA100 included a review of the site closure document (USAF, 2002c) and associated analytical data. The site closure report concluded that NFA is needed at SA100 because all contaminated debris and soils were excavated and disposed during the 2001 removal action. The site closure report indicated the removal action at this site would be documented in the final Elmendorf AFB NPL Construction Completion documentation. The USAF, EPA, and ADEC signed the *SA100 Removal Action and Site Closure* report in May 2002.

In addition, a site inspection was performed on May 16, 2003 by O&M staff. The site inspection indicated land use changes: the site was transformed into a residential area. There is documentation that all contaminated media was removed from the site prior to construction of the new housing development. Soil confirmation sampling and site closure documents indicate residential/background cleanup levels have been met and unlimited use and unrestricted exposure is acceptable for SA100.

Section 7.0
TECHNICAL ASSESSMENT

The protectiveness of the remedy is analyzed in this technical assessment, which was completed by answering three questions for each OU, as described below.

- Question A: Is the remedy functioning as intended in the decision documents?

  This question was answered by considering the remedy's implementation status (Section 4), available information reviewed in Section 6, and comparing the remedy to the requirements in the ROD and remedial design/construction specifications. Remedial action performance, system O&M, monitoring, costs, land use controls, and indicators of potential problems were assessed.

- Question B: Are the exposure assumptions, toxicity data, cleanup levels and RAOs used at the time of the remedy selection still valid?

  Question B was answered by evaluating the effects of significant changes in standards and assumptions that were used at the time of remedy selection that may impact the protectiveness of the remedy. In addition, TBCs used in preparation of the ROD were evaluated to determine whether new toxicity data would cause additional compounds, not considered at the time of the ROD, to become a potential concern.

  This evaluation was done according to EPA Guidance (June 2001): "Generally you should only consider changes in standards that were identified as ARARs in the ROD, newly promulgated standards for COPCs, and TBCs identified in the ROD that bear on the protectiveness of the remedy. As such, you should review any newly promulgated standards, including revised chemical-specific requirements (such as MCLs, ambient water quality criteria), revised action and location-specific requirements, and State standards if they were considered ARARs in the ROD. In evaluating a change in a standard that was identified as an ARAR in the ROD, or a newly promulgated standard or TBC, you should establish whether the new requirement indicates that the remedy is no longer protective."

  The evaluation of new or changed standards was accomplished by first comparing historical and current state or federal cleanup levels to identify changes in standards, newly promulgated standards for COPCs, and other TBCs. Cleanup levels for COPCs presented in the ROD were compared to current applicable federal or state cleanup levels. Table B-1 in Attachment B illustrates this evaluation and identifies the COPCs for which a new standard or more stringent standard was found.

  The COPCs with new or more stringent standards were further evaluated by comparing the current applicable standard with maximum detected levels, as shown in Table B-2 in Attachment B. Risk calculations were performed for COPCs where current maximum detected levels exceed this standard. Cancer risks and non-cancer hazards were estimated by comparison with ADEC's risk-based standards for soil and groundwater presented on Tables B-1 and B-2. The ADEC groundwater and direct contact soil standards are based on a one in one hundred thousand risk (1×10^{-5}) for carcinogens or a hazard quotient of 1 for non-cancer chemicals. Because the risk/hazard equations are linear, increasing the concentration by a factor increases risks by the same amount (i.e., if a site carcinogenic chemical's concentration is five times the ADEC standard, then it represents a risk of 5×10^{-5} if all exposure and toxicity assumptions remain the same). Therefore, risks and hazards were calculated by evaluating the magnitude of their exceedance above ADEC

standards. This is equivalent to using Equations 1 and 2 from the ADEC Cleanup Levels Guidance (ADEC, 2002) for groundwater and Equations 6 and 7 from the ADEC Cleanup Levels Guidance (ADEC, 2002) for soils, as agreed by EPA, ADEC, and USAF during the Quarterly Remedial Project Manager's Meeting held on June 11, 2003 and subsequent correspondence. Table B-3 includes these calculations.

Note that Equations 6 and 7 of ADEC's cleanup level guidance (for soils) represent the inhalation pathway, the direct contact pathway of most concern for the volatile chemicals listed in Table B-3. The lowest, most conservative cleanup levels for these compounds in soil is the migration-to-groundwater pathway. However, the migration-to-groundwater pathway does not represent the human health risks from direct exposures to soil; therefore, the lowest direct contact pathway equation is more appropriate at these sites and was used to estimate health risks. Although the ingestion pathway for volatile compounds in soil is not included, the slight underestimation of risks is unlikely to be significant within the context of evaluating whether the RAOs are protective for these sites.

Finally, an evaluation was made as to whether the remedy remains protective. The EPA's risk management decision range is 1 $x10^{-4}$ to 1 $x10^{-6}$ for carcinogens and a hazard quotient of 1 for non-carcinogens. For the COPCs shown in Table B-2 that require further evaluation, risk/hazard levels were calculated, as shown in Table B-3, to evaluate whether EPA's target health goals were exceeded and results are discussed in the following subsections.

As part of this evaluation, the effect of significant changes in risk parameters that were used to support the remedy selection, such as reference doses, cancer potency factors, and exposure pathways of concern, were reviewed. In addition, the validity of the original assumptions regarding current and future land/groundwater uses and COCs, and any changes in physical features were reviewed.

The evaluation of TBCs and new toxicity data that would cause additional compounds or requirements to become a potential protectiveness concern is summarized in Table B-4. Six compounds (associated with one or more of the OUs) with new toxicity criteria were identified and include TCE, vinyl chloride, benzene, xylenes, tetrachloroethene, and 1,1,1-trichloroethane. Table B-4 shows the evaluation of risks and hazards that were calculated for each of these compounds using the new reference doses and cancer slope factors.

Using ADEC methodology and the new toxicity data, the calculated risks indicate that the current cleanup standards for the six compounds are still within EPA's risk management decision range (i.e., 1 $x10^{-4}$ to 1 $x10^{-6}$ for carcinogens and a hazard quotient of 1 for non-carcinogens).

- Question C: Has any other information come to light that could call into question the protectiveness of the remedy?

  This question was answered primarily during the data and document review in Section 6 as well as documentation of any decisions or agreements made with the agencies. Any analytical data that is available, and not currently monitored as a COC, that resulted in compounds exceeding current cleanup levels is identified in this section. In addition, any ecological risks that have not been addressed at the site or any known plans for potential land use changes may be included in this section.

The USAF agreed, during a meeting held with EPA and ADEC on January 14, 2003, because both DRO and GRO have been shown to be associated with non-carcinogenic human health risks since the signing of the RODs, funding will be included to add DRO and GRO to the sampling scheme of the Basewide Groundwater Monitoring Program. This will apply to monitoring at wells associated with fuel plumes. It was also agreed that until a decision document is signed with ADEC, concentrations will be compared to the current cleanup levels of 1,500 µg/L and 1,300 µg/L for DRO and GRO, respectively (18 AAC 75) in annual reports and subsequent five year reviews. The USAF will not be required to add DRO and GRO as a CERCLA ARAR.

7.1 Operable Unit 1

Question A: Is the remedy functioning as intended in the decision documents?

Answer: Yes: At OU1 the selected remedy includes natural attenuation of the COCs in groundwater for five years or until the groundwater no longer poses an unacceptable health risk and the implementation of LUCs to limit exposure to the COCs. Monitoring documents that natural attenuation has been effective at OU1, and TCE and manganese are the only remaining COCs. Data indicates that TCE concentrations have decreased at OU1; of the 4 wells sampled in 2002, only one well, LF59-MW-03 in Site LF59, remains above the cleanup level of 5 µg/L. No wells had manganese levels reported above background concentrations in 2001 or 2002. In addition, the processes used to manage, track, and enforce LUCs are working effectively to mitigate potential exposure to contaminants.

Question B: Are the exposure assumptions, toxicity data, cleanup levels and RAOs used at the time of the remedy selection still valid?

Answer: Yes: A comparison of historical and current state or federal criteria found newly promulgated standards for 1,1,2,2-tetrachloroethane and PCBs in groundwater (see Table B-1 in Attachment B). The PCB concentration measured as part of preparation for the ROD was only detected in one well (one out of 38 samples) and subsequent sampling events failed to confirm the presence of PCBs; therefore, the data was not validated and the remedy is considered to remain protective for this COPC. For 1,1,2,2,-tetrachloroethane, the current maximum detected level (18 µg/L in well LF59-MW-03) is higher than the new standard of 4 µg/L (see Table B-2 in Attachment B); however, the calculated risk of $5x10^{-5}$, based on Equation 2 (ADEC, 2002b) is within EPA's risk management decision range (the upper limit is 10^{-4}, see Table B-3 in Attachment B). Protectiveness of the remedy for this compound is further assured because, (1) toxicity data and exposure assumptions have not changed for1,1,2,2-tetrachloroethane, (2) analytical results for 1,1,2,2-tetrachloroethane are regularly received as part of the VOC analytical suite for the COCs at this site, and (3) the remedy appears to be effectively remediating similar compounds (Like TCE, 1,1,2,2-tetrachloroethane is a chlorinated solvent and follows a similar natural attenuation process and is not found in the downgradient well LF59-MW-06R).

The original risk assessment for the site found potential unacceptable risks/hazards if groundwater was used as a source of drinking water based on either residential or commercial/industrial land use. Risks from exposures to soil did not exceed target health goals. LUCs prevent groundwater use as a source of drinking water and no significant land use changes have occurred at the site.

Toxicity information has changed for two of the COCs: TCE and vinyl chloride. Based on updated information in the scientific literature, there is a revised, more stringent, cancer slope factor for vinyl chloride (EPA, 2003) and a provisional cancer slope factor for TCE has been calculated by EPA (EPA, 2001b). EPA Region 10 risk assessors recommend the use of this

provisional slope factor, as the best available science, for all TCE evaluations in Region 10 at this time. Table B-4 in Attachment B shows that using the new toxicity data, the standards specified in the ROD are still within EPA's risk management range for these compounds. All other exposure assumptions, toxicity data, cleanup levels, or RAOs used at the time of the remedy selection have not changed since the signing of the ROD and remain valid at this time. All OU1 ROD-specified COC cleanup levels are still appropriate and protective.

Question C: Has any other information come to light that could call into question the protectiveness of the remedy?

Answer: No.

7.2 Operable Unit 2

Question A: Is the remedy functioning as intended in the decision documents?

Answer: Yes: At OU2, the ROD-selected remedy included a free product and dissolved phase recovery treatment system, source removal (tanks, piping, and contaminated soil), long-term monitoring of groundwater and natural attenuation progress and the implementation of LUCs. Since the ROD was signed in 1995, free product has been removed, dissolved phase contaminants have been treated, source removal has occurred, and monitoring results show that BTEX concentrations are decreasing over time via natural attenuation. In addition, the processes used to manage, track, and enforce LUCs are working effectively to prevent potential exposure to contaminants.

Recent monitoring results, reviewed in Section 6.3.2, show that BTEX concentrations in part of the southern plume at ST41 exceed the concentrations predicted in the Bioplume model completed in 2000. The calibration of the 2000 model may be incorrect and the concentrations of BTEX at ST41 may not reach cleanup levels by 2016, as predicted. However, data shows that this plume is shrinking and is not migrating from the site.

Question B: Are the exposure assumptions, toxicity data, cleanup levels and RAOs used at the time of the remedy selection still valid?

Answer: Yes: Similar to OU1, a comparison of historical and current state or federal cleanup levels found a newly promulgated standard for 1,1,2,2-tetrachloroethane in groundwater (see Table B-1 in Attachment B). The new standard for 1,1,2,2-tetrachloroethane is 4 µg/L. The latest groundwater monitoring results indicate that 1,1,2,2-tetrachloroethane was not detected at a method reporting limit of 0.69 µg/L (see Attachment B), therefore the remedy is considered to remain protective for this COPC. The new standard is risk-based and, if concentrations were present at the level of the standard, risks would not exceed the ADEC target risk goal of 1×10^{-5} (1,1,2,2-tetrachloroethane is a carcinogen). In addition, the new federal standard for 1,2-dichloroethane in surface water is 3.8 µg/L. Although 1,2-dichloroethane has not been detected in the surface water at OU2, the maximum reported detection limit of 5.7 µg/L exceeds the federal standard. To be conservative, this reporting limit was used as the maximum detected concentration to calculate risk. The result is a risk of 2×10^{-5}, which is within EPA's acceptable risk management range, as shown in Tables B-2 and B-3 (Attachment B).

The original risk assessment for the site found potentially unacceptable risks/hazards (primarily due to benzene) if groundwater was used as a source of drinking water based on either residential or commercial/industrial land use. No risks/hazards above target health goals were identified for the other media evaluated (e.g., soil, sediment, surface water) in the original assessment. LUCs prevent groundwater use as source of drinking water and no significant land

use changes have occurred at the site. Land use restrictions remain in place to limit the site to undeveloped recreational use and actual use continues to be minimal. All exposure assumptions, cleanup levels or RAOs used at the time of the remedy selection remain valid at this time.

Toxicity information has changed for three of the COCs: benzene, ethylbenzene and xylenes. Specifically, ethylbenzene is now considered a potential carcinogen by inhalation and an inhalation slope factor has been proposed by EPA, and non-cancer reference doses for oral and inhalation exposures have been revised downwards (more stringent) for benzene and xylenes. Table B-4 in Attachment B shows that using the new toxicity data, the cleanup standards specified in the ROD are still within EPA's risk management range for these compounds. All other exposure assumptions, toxicity data, cleanup levels or RAOs used at the time of the remedy selection remain valid at this time. The OU2 ROD-specified COC cleanup levels are still considered protective.

Question C: Has any other information come to light that could call into question the protectiveness of the remedy?

Answer: Yes: Levels of benzene in the seep on the north side of ST41 exceeded cleanup levels in 2002; however, the point of compliance established for protectiveness of the wetland at OU2 is downgradient of the current seep sampling location. It is predicted that, at the point of compliance, contaminant concentrations will be below surface water quality criteria (SWQC), as established in the OU2 ROD. This was confirmed as recently as 2001, and will be confirmed annually starting in 2003.

The 2002 annual technical report for the Basewide Monitoring Program indicates that the method (hand-bailing) used to remove the remaining free product from the wells has not been effective for groundwater (USAF, 2003b). However, because the ROD requirements for removing all technically practicable free product with the IRA system have been met, remedy protectiveness is not in question.

7.3 Operable Unit 4

Question A: Is the remedy functioning as intended by the decision documents?

Answer: Yes. The OU4 bioventing systems continue to operate and function as designed. Soil monitoring data shows that COC concentrations have decreased significantly over the five years that the bioventing systems have been in operation. Closure sampling at SD25 in 1999 and 2002 indicates that soil cleanup levels acceptable for residential use have been achieved and soil remediation at SD25 is complete (USAF, 2002d).

In-situ respiration testing in 2001 indicated that bioventing continued to enhance hydrocarbon degradation at SS10 while data from FT23 (FTA-1 location) indicated that only low levels of hydrocarbon contamination remain in the subsurface. The original bioventing treatability study areas met cleanup levels at both FTA-1 and FTA-2. Later, in 2002, the system at FTA-1 was expanded to address contamination at SB-62, a soil boring location not previously included in the original bioventing treatability study. Therefore, the system has successfully remediated contaminants as intended by the decision documents and the system has been expanded and continues to operate to address newly found contamination. Bioventing system O&M procedures and LUCs continue to ensure protectiveness of the system.

For groundwater at OU4, the major components of the selected remedy are: (1) biannual groundwater monitoring to evaluate contaminant migration and timely reduction of contaminant concentrations by natural attenuation, and (2) the implementation of LUCs that limit exposure to the shallow aquifer. Each of these components has been implemented and is functional. For the

first remedy component, natural attenuation is occurring, but degradation of chlorinated compounds may take longer to meet cleanup levels than predicted by the groundwater models and stated in the ROD (by 2008). As for the second component, the processes used to manage, track, and enforce LUCs are working effectively to prevent potential exposure to contaminants.

Question B: Are the exposure assumptions, toxicity data, cleanup levels, and RAOs used at the time of the remedy selection still valid?

Answer: Yes. There is a newly promulgated groundwater standard for 1,1-dichloroethane (see Attachment B, Table B-1). The maximum detected level of 14 µg/L in 2002 is below the new standard of 3,650 µg/L for 1,1-dichloroethane; therefore, the new standard is being met at the site and the remedy is still considered protective for this COPC. The new standard is risk-based and, if concentrations were present at the level of the standard, hazards would not exceed the target hazard quotient goal of 1 (1,1-dichloroethane is a non-carcinogen).

For soil, there have been numerous newly promulgated state soil cleanup levels that apply to the COPCs identified in the ROD (see Attachment B, Table B-1). Of these, the only COPCs that had maximum detected levels that exceed the new standard are 1,1,1- trichloroethene (2.9 µg/L), benzene (0.043 µg/L), and methylene chloride (0.092 µg/L) (see Attachment B, Table B-2). However, the associated calculated risks are within EPA's risk management decision range (i.e., risk is less than 1×10^{-6} for carcinogens and the hazard is less than 1 for the non-cancer chemical, see Table B-3 in Attachment B). Note that the risk and hazard quotient estimates presented in Tables B-2 and B-3 (Attachment B) appear slightly underestimated because they do not include the ingestion pathway; however, because the estimated risks are orders of magnitude below a level of concern, the addition of the ingestion pathway would not affect the conclusions of this evaluation. The new soil inhalation standards are risk-based and, if concentrations were present at the level of the standards in Table B-3, risks would not exceed the ADEC target risk goal of 1×10^{-5} for carcinogens or a hazard quotient of 1 for non-carcinogens. The protection-of-groundwater cleanup levels presented in Table B-2 for soil are not risk-based levels for direct exposures to soil; they represent the soil concentrations that will not cause an increase in groundwater concentrations above a risk-based groundwater concentration if the chemicals leach from soil. Therefore, exceedances above the protection-of-groundwater cleanup levels do not represent exceedances of target health goals from exposures to soil, as shown in Table B-3 (Attachment B).

The original risk assessment identified risks above target health goals if groundwater was used as a drinking water source under either a future residential or a current/future commercial/industrial land use scenario. No risks/hazards from soil exposures exceeded target health goals. LUCs prevent groundwater use as a source of drinking water and no significant land use changes have occurred at the site. The site use remains commercial/industrial, specifically, military buildings staffed by civilian and military personnel. All exposure assumptions, cleanup levels or RAOs used at the time of the remedy selection remain valid at this time and are still protective according to the current regulatory cleanup levels.

Some of the groundwater plume areas are under existing buildings (OU4W-04 and FP-56/OU4W-11) and vapor intrusion into buildings was not a pathway that was evaluated in the original risk assessment. However, the cleanup levels specified for groundwater in the ROD are protective of the drinking water pathway and given the environmental conditions at the OU, concentrations protective of drinking the water would also be protective of human health due to vapor intrusion (a less intensive exposure than drinking water at this site).

Toxicity criteria have been revised for five of the COCs: TCE, benzene, ethylbenzene, tetrachloethene, and 1,1,1-trichloroethane; however, the standards for these chemicals in

groundwater and soil have not changed. Table B-4 in Attachment B shows that using the new toxicity data, the cleanup standards specified in the ROD are still within EPA's risk management range for these compounds. Current concentration information indicates these compounds are not a health risk. All OU4 ROD-specified cleanup levels for COCs are therefore still considered protective (see Attachment B). In addition, the remedy appears to be effectively remediating benzene, currently monitored via the BTEX analysis.

Question C: Has any other information come to light that could call into question the protectiveness of the remedy?

Answer: No.

7.4 Operable Unit 5

Question A: Is the remedy functioning as intended by the decision documents?

Answer: Yes. The remedy at OU5 is functioning as intended. As discussed in Section 6.3.4, groundwater sampling has shown that the remedy is reducing hydrocarbon contaminants at OU5. It appears that natural attenuation for TCE is working more slowly than predicted and cleanup levels for TCE may not be met by 2026.

The OU5 WRS and Beaver Pond continue to operate and function as designed. Seep water from OU5 continues to be collected and treated through the WRS. Past and current sampling of the seeps, WRS influent, and WRS effluent shows that contaminated water enters the system, but no water leaves the system with contaminants above cleanup levels. To date, there have been no contaminants above cleanup levels in effluent water. Annual reports and quarterly technical memorandums from 1997 to the present provide analytical data collected from the WRS and Beaver Pond.

System O&M procedures continue to keep the system operating as designed.

A wetland cell vegetation study, conducted in 2001 (USAF, 2002e) found the wetlands to be in excellent condition. High densities of healthy plants were found, which indicates good survivability. The study also determined the optimal water level in the wetland cell that would ensure the future health of system vegetation. In addition, the processes used to manage, track, and enforce LUCs are working effectively to prevent potential exposure to contaminants.

Question B: Are the exposure assumptions, toxicity data, cleanup levels, and RAOs used at the time of the remedy selection still valid?

Answer Yes: A comparison of historical and current state or federal cleanup levels found newly promulgated state standards for five chemicals in water: 1,1-dichloroethane, 1,1,2,2-tetrachloroethane, di-n-butly phthalate, diethyl phthalate in groundwater, and naphthalene in surface water (see Attachment B, Table B-1). In addition, the newly promulgated federal standard for 1,2-dichloroethane in surface water (3.8 µg/L) is stricter than the current state standard (5 µg/L), as shown in Table B-1. The new standards for 1,1-dichloroethane; di-n-butyl phthalate; diethyl phthalate; naphthalene, and 1,2-dichloroethane are greater than the maximum detected levels; therefore, the remedy is considered to remain protective for these COPCs. For 1,1,2,2,-tetrachloroethane, the maximum detected level of 6.2 µg/L in 2002 exceeds the new standard of 4 µg/L. The resulting calculated risk is $2x10^{-5}$, which is within EPA's risk management decision range. Protectiveness of the remedy for this compound is further assured because, (1) toxicity data and exposure assumptions have not changed for1,1,2,2-tetrachloroethane, (2) analytical results for 1,1,2,2-tetrachloroethane are regularly received as part of the VOC analytical suite for the COCs at this site, and (3) the remedy appears to be effectively remediating similar compounds.

Because Alaska Water Quality Standards no longer specify the analytical methods TFH-Diesel and TFH-Gas, a minor change was made to the hydrocarbon cleanup levels agreement with ADEC and EPA in 1998. TFH-diesel and TFH-gas (groundwater) and TFH-gas, TPH and "no sheen" (surface water) in the sampling program were replaced with TAH and TaqH. The revised methods and cleanup levels provide equivalent protection of human and environmental receptors and bring the cleanup levels in line with current ADEC regulations (Attachment B). Detection levels for the new methods are lower and provide data that can be compared to cleanup levels.

The original risk assessment evaluated several different exposure populations due to varied land use occurring at the site:

- Current/future residents exposed to soil and groundwater used for drinking;
- Current/future workers exposed to soil in the industrial area of the OU; and
- Current/future recreational uses of the lowland exposed to sediment/surface water areas.

Risks above target health goals were found only from the hypothetical use of groundwater as a drinking water source. LUCs prevent groundwater use as a source of drinking water and no significant land use changes have occurred at the site. Some groundwater plume areas may be under existing commercial buildings and vapor intrusion into buildings was not a pathway that was evaluated in the original risk assessment. However, the cleanup levels specified for groundwater in the ROD are protective of the drinking water pathway and given the environmental conditions at the OU, concentrations protective of drinking the water would also be protective of human health due to vapor intrusion (a less intensive exposure than drinking water at this site). Other exposure assumptions, cleanup levels or RAOs used at the time of the remedy selection remain valid at this time and are still protective according to the current regulatory cleanup levels.

Toxicity criteria have changed for two of the COCs: TCE and benzene. As shown in Table B-4 (Attachment B), the changes in toxicity criteria do not affect the cleanup standards selected in the ROD. Therefore, all OU5 ROD-specified cleanup levels are still considered protective.

Question C: Has any other information come to light that could call into question the protectiveness of the remedy?

Answer: Yes. Although the seeps currently captured are being effectively remediated, additional seeps have been discovered which contain TCE in excess of cleanup levels. At present, TCE has not exceeded cleanup levels at the point of compliance (Ship Creek). However, the source and extent of the TCE has not been adequately characterized and the potential exists for increased levels of TCE to discharge to surface water. Therefore, the current protectiveness of this remedy to prevent exposure at this contaminated seep is in question. Implementation of the recommendations provided in Section 9 will provide protectiveness in the long-term.

A review of analytical data collected in 2002 showed that the concentrations of 1,1,2,2-tetrachloroethane and tetrachloroethene were above the ADEC groundwater cleanup level in two wells (see Section 6.3.4). These compounds were not identified as COCs in the OU5 ROD. Like TCE, tetrachloroethene and 1,1,2,2-tetrachloroethane are chlorinated solvents and follow similar natural attenuation processes. The presence of low concentrations of these chemicals should not affect the protectiveness of the remedy. This is evidenced by the sample results for the effluent from the Beaver Pond, which have been non-detect for these chemicals, indicating the remedy is

effectively remediating these compounds prior to the point of compliance (located downgradient of the Beaver Pond at Ship Creek).

7.5 Operable Unit 6

Question A: Is the remedy functioning as intended by the decision documents?

Answer: Yes. All remedial actions are operating and functioning. Although monitoring data indicates that the HVE system at SD15 is not effectively remediating two areas of shallow soil contamination, a treatability study is being implemented to address these areas. In addition, the asymptotic trend for contaminant removal associated with the HVE system at SD15 may be an early indicator that the remedy may not achieve cleanup levels within the timeframe intended by decision documents.

Possible migration of contaminants from soils having DRO, GRO, and BTEX concentrations exceeding ACM Level D cleanup levels exists at SD15 at two locations in relatively shallow soils above the perched aquifer and in soils from the 9 to 11 feet bgs depth interval (refer to Section 6.3.5). As currently configured, the HVE system is not currently, nor is it designed to treat the contaminants that remain in the shallow soils. A treatability study is currently being implemented for the shallow soils to determine if the HVE system can be modified to treat these areas. The treatability study will evaluate modifications to the HVE system that incorporate SVE at the two remaining areas of shallow soil contamination (near the wells where COC levels exceed cleanup levels) and includes four new wells that are incorporated into the existing HVE system piping.

Groundwater monitoring data shows that benzene and TCE concentrations at SD15 continue to remain above cleanup levels after five years of HVE operation. COC concentrations are significantly less than levels identified in 1994 and 1995; however, no discernable statistical trends have been established since 1997 for decreasing concentrations of benzene and TCE with the exception of benzene at OU6MW-90 and TCE at OU6MW-17. This, as well as indications that active remediation by HVE is approaching steady-state conditions, indicates that the gross contaminant removal for which the HVE system was designed, may be nearing completion.

Major maintenance performed in 2002 has rectified problems that resulted in significant downtime in previous years (refer to Section 6.3.5) and the resulting improved operational rate will likely result in more consistent system operation and removal of additional contamination. However, because the technology isn't designed to remove very low levels of contaminants, it is unlikely that the existing system will efficiently remediate contaminants to the extent needed to meet cleanup levels.

Groundwater monitoring is continuing at all OU6 locations in accordance with the Environmental Monitoring Plan. LUCs have been established to prevent development or human exposure to contamination at source areas. Site conditions and land use are consistent with the OU6 ROD requirements and remain protective, based on an evaluation of current monitoring data and trends. The time frames given in the OU6 ROD to reach cleanup levels for groundwater at SD15 and at WP14/LF04 South will take longer than estimated.

The cleanup at WP14/LF04 South will take longer than expected due to continued migration of fuel contamination from upgradient source area PL81. To decrease the suspected source of hydrocarbon contamination, a performance-based contract is projected for the PL81 Valve Pit 11 area (State agreement). Contaminated soil in the vadose zone will be treated by a technology chosen by the contractor to clean up the soil to ADEC standards. The contract will begin in 2004 and continue through 2006.

The remedy is considered protective in the short-term because LUCs are in place, and there is no current or potential exposure. The lack of a decreasing trend beyond current concentrations in two COCs (benzene and TCE) at some locations is a long-term concern. Follow-up actions have been necessary to address long-term protectiveness. Major system maintenance and planned operational modifications to address the remaining soil contamination are expected to establish future decreasing trends of the remaining COCs.

Question B: Are the exposure assumptions, toxicity data, cleanup levels, and RAOs used at the time of the remedy selection still valid?

Answer: Yes. Since the signing of the ROD, there have been several newly promulgated state soil cleanup levels that apply to the COPCs identified in the ROD (see Attachment B, Table B-1) and one new groundwater standard for 1,1,2,2-tetrachloroethane (this does not apply to area LF02 which had a risk-based groundwater standard in the ROD for this chemical). A review of maximum detected levels indicates that all of these COPCs are within current applicable standards (see Attachment B, Table B-2); therefore, the remedy is considered protective. In addition, the remedy appears to be effectively remediating BTEX, which is currently monitored as a COC.

In general, risks were primarily identified only if groundwater was used as drinking water at most of the six areas investigated within OU6 and soils were much less of a concern (with the exception of soil at LF04 and LF02). LUCs prevent groundwater from being used as a drinking water source and there are no significant land use changes for the six areas. Exposure assumptions, cleanup levels or RAOs used at the time of the remedy selection remain valid at this time and are still protective according to the current regulatory cleanup levels.

Toxicity criteria have changed for three of the COCs: TCE, benzene, and ethylbenzene (see Table B-4, Attachment B). As discussed previously for other OUs, the toxicity criteria changes do not affect the selected RAOs and because current concentrations are below ADEC risk-based levels, concentrations are not a health concern.

Data from beach soil and sediment samples collected from the LF04 site in December 2002 were compared to current state and federal risk-based standards to determine if changes in current standards impact the protectiveness of the remedy. However, no changes in these risk-based standards call into question the protectiveness of the remedy. In fact, the data confirm that, in general, contamination levels have decreased since the 1996 RI/FS and new standards do not impact the protectiveness of the remedy. Therefore, the NFA determination for soil contamination at the LF04 beach is appropriate. The only COC for the LF04 beach continues to be exposed landfill debris.

Question C: Has any other information come to light that could call into question the protectiveness of the remedy?

Answer: Yes. Since implementation of the remedy identified in the ROD, small arms casings and rounds have been discovered on the LF04 beach. These reports of possible ordnance and explosives created a need for Elmendorf Explosive Ordnance Disposal (EOD) to respond, inspect, collect, and dispose of suspect items. Fencing between base and port properties was strengthened and signs warning of potential explosive hazards were posted in 2000. Additionally, port security controlled entry, base security patrols, and routine wildlife law enforcement patrols ensure that LUCs continue to limit access to the beach area. EOD will continue to respond, to inspect and properly dispose of suspect items in addition to performing routine EOD walks during the summer season. CEVR personnel perform beach walks monthly, generally May through September after extreme high tide, to monitor any changes at the beach.

Erosion studies have determined that the erosion rate at the LF04 beach and bluff for the last 15 years is about three feet per year and does not appear to be increasing. The projected period for the landfill to completely erode is 200 years. A five-year review fact-finding study included consideration of seven alternatives for addressing erosion and reducing debris and contaminant deposits on the beach. The results indicated that based on cost, the insignificant amount of hazardous debris found, and the fact that 2002 contamination levels were less than or equal to contamination levels found during the 1996 RI/FS with a few exceptions, the annul beach sweep remains the most practicable remedy for LF04 at this time (see Section 6.3.5.1).

Although the erosion treatment alternatives evaluated may not be practicable for the entire landfill, one or more of the alternatives applied to a limited area, where high concentrations of debris are located, may be warranted (i.e., spot removal or a limited retaining wall used with above-bluff drainage). The Operations and Management Plan for LF04 makes provisions for extensive sampling every five years plus exploratory study of some specific areas of the bluff. The results of this data collection effort will determine if application of a limited treatment alternative to these high-concentration areas would be a beneficial and cost-effective option for accelerating the timeframe for remedy completion. In the meantime, the beach sweep and LUCs remedy continues to ensure protectiveness because contaminant levels are not increasing and the amount of hazardous debris found has been insignificant.

In addition, new information collected during the 2002 sampling event at LF04 found elevated levels of benzene, DRO, and GRO at Seep 2. To ensure protectiveness, an additional location downgradient of Seep 2 was sampled. These analytes were detected at levels below ADEC groundwater cleanup levels thus ensuring protectiveness of environmental receptors.

7.6 SA100

Question A: Is the remedy functioning as intended by the decision documents?

Answer: Yes. Although no ROD was prepared for this site, the confirmation sampling, closure report, and site inspection conducted for this site confirm that the removal action was successful and no further action is needed at this site.

Question B: Are the exposure assumptions, toxicity data, cleanup levels, and RAOs used at the time of the remedy selection still valid?

Answer: Yes.

Question C: Has any other information come to light that could call into question the protectiveness of the remedy?

Answer: No.

7.7 Technical Assessment Summary

Past and current data from system monitoring indicate that the remedies are performing as intended by the decision documents for OUs 1, 2, 4, 5, and 6. Because cleanup levels acceptable for residential use have been met for all COCs at LF05, LF07, LF13, and OT56 in OU1; unlimited use and unrestricted exposure is acceptable, no future action is required, and theses sites will not be subject to further five-year reviews. In addition, cleanup levels for all COCs except TCE have been met at LF59 in OU1 and TCE will continue to be monitored at LF59 as part of the Basewide Groundwater Monitoring Program. Following closure of LF05, LF07, LF13, and OT56, LUCs will continue to be maintained at LF59 until it is demonstrated that TCE meets cleanup levels.

The agencies have agreed that OU4 bioventing sites SD25 and FT23 (FTA-2) qualify as NFA for soil because analytical data documents that the soils at SD25 and FT23 (FTA-2) have met the OU4 ROD cleanup levels, which are acceptable for residential use. LUCs will be maintained throughout OU4 until it is demonstrated that groundwater contaminant concentrations meet cleanup levels and unlimited use and unrestricted exposure at the site(s) is acceptable.

SA100 is considered closed: it has been confirmed that response actions resulted in meeting cleanup levels that allow for unlimited use and unrestricted exposure and land use controls are not needed.

Monitoring data indicates that, in general, remediation of contaminants is occurring; however, it appears that the cleanup schedules predicted in the RODs may not be met at several sites. These include:

- At OU2, BTEX may not meet the cleanup level at ST41 by 2016.
- For groundwater at OU4, TCE in the East Plume and 1,1,1-tetrachloroethane and TCE, and 1,2-dichloroethene in the FTA Plume as well as benzene in the OU4 West plumes may not meet cleanup levels at OU4 by 2008.
- At OU5, TCE may not meet the groundwater cleanup level by 2026.
- For groundwater at OU6, hydrocarbon contamination at WP14/LF04 South may not meet cleanup levels by 2025.
- Benzene and TCE at SD15 in OU6 may not reach the cleanup level within five-years of HVE system operation. An asymptotic trend for contaminant removal associated with the HVE system at SD15 may be an early indicator that the remedy is approaching design limitations for low-level contaminant removal required to achieve cleanup levels.

Because the HVE system at SD15 is not expected to effectively remediate two areas of shallow soil contamination, a treatability study to incorporate SVE is currently being implemented to address these areas.

There have been no changes to the physical conditions of the sites that could affect the protectiveness of the remedies. A review of changes in exposure assumptions, toxicity data, and cleanup levels since the time of the remedy selection has not revealed any issues that affect remedy protectiveness. All of the cleanup levels for the final COCs are still protective according to the current regulatory cleanup levels and associated risk evaluations.

Since the time of the RODs, both DRO and GRO have been shown to be associated with non-carcinogenic human health risk. It has been agreed between ADEC, EPA, and USAF that these analytes will be added to the Basewide Groundwater Monitoring Program beginning in 2004. DRO and GRO will be compared to current State regulatory standards and will not be added as ARARs under CERCLA.

At OU5, newly identified seeps with elevated TCE that are not captured by the system call into question the current protectiveness of the remedy (see Section 7.4). To date, TCE has not exceeded cleanup levels at the point of compliance (Ship Creek).

Section 8.0
ISSUES

This section details issues related to current site operations, conditions, or activities and evaluates whether the issues affect current or future protectiveness of the associated remedy. Table 8-1 summarizes the issues at each OU.

Table 8-1

Issues

Item No.	OU	Site	Issues	Affects Current Protectiveness? (Y/N)	Affects Future Protectiveness? (Y/N)
1	2	ST41	Surface Water. Levels of benzene in the seep on the north side of ST41 exceeded cleanup levels in 2002. The point of compliance established for protectiveness of the wetland at OU2 is downgradient of the current seep sampling location and it is expected that the point of compliance contaminant concentrations will be below Alaska SWQC. This was confirmed in 2001; however, recent monitoring does not include TAH and TAqH analyses to ensure compliance with Alaska SWQS as established in the OU2 ROD. In the interim, LUCs ensure current protectiveness.	N	N
2	5	ST37	Additional Contaminated Seeps: In 2001, the USAF sampled seeps that are not being collected and treated in the WRS. Data from three seeps (Seeps 9, 10, and 11) indicated the presence of TCE contamination above cleanup levels. A study performed in 2002 (USAF, 2002e) determined that the existing wetland has the capacity to treat the additional loading of TCE. In 2003, the USAF will contract design of additional discharge structures to capture the three seeps and divert them to the WRS. Construction of the discharge structures will take place in 2004. In addition, the USAF has initiated further investigation into the suspected source and extent of the Kenney Ave Plume and modeling is scheduled for later this year. To ensure that other contaminated seeps are not exiting the bluff, all seeps at OU5 have been sampled annually since 2001. All OU5 seeps will continue to be monitored at least annually until cleanup levels are met. This work will ensure current and future protectiveness.	N	Y
3	2, 4, 5, 6	ST41, SS10, FT23, SD24, SD28, SD29, ST37, SD15, LF04, WP14	Cleanup Schedules: Although monitoring has shown that the remedies are reducing contaminants, it appears to be occurring at a slower rate than predicted by the RODs and/or models. Although LUCs are in place to ensure protectiveness in the interim, cleanup levels may not be achieved within the timeframes specified in the RODs. This includes: • BTEX at OU2 may not reach cleanup levels by 2016. However, data shows that this plume is shrinking and is not migrating from the site. • At OU4, TCE concentrations in the East Plume are attenuating naturally, however it is likely that the cleanup duration may exceed the ROD-predicted timeframe, ending in 2008. • For FTA Plume (OU4 FT23), the chlorinated compounds are degrading more slowly than predicted by the models. TCE,	N	N

Table 8-1 (Continued)

Item No.	OU	Site	Issues	Affects Current Protective-ness? (Y/N)	Affects Future Protective-ness? (Y/N)
			tetrachloroethene, and 1,2- dichloroethene may not reach cleanup levels by 2008. • For OU4 West plumes (specifically, at wells OU4W-08 and OU4W-04), remediation of benzene may not reach the cleanup level by 2008. • The bioventing system at OU4 site FT23 was expanded in 2003 to address additional soil contamination discovered at this site. Soil cleanup levels in the new area may not be met by 2008. • At OU5, groundwater sampling has shown that TCE is remediating at a slower rate than predicted and cleanup levels for TCE may not be met by 2026. • At OU6, COCs in groundwater at the WP14/LF04 South area may not meet cleanup levels by 2025, as anticipated by the ROD. A performance-based contract is projected for the PL81 Valve Pit 1 area to treat contaminated soil in the vadose zone to ADEC cleanup levels (per State agreement), which is expected to decrease the suspected source of hydrocarbon contamination and improve the groundwater cleanup schedule. • At SD15 (OU6) benzene and TCE concentrations remain above cleanup levels and no discernable decreasing statistical trends have been established since 1997, with the exception of benzene at OU6MW-90 and TCE at OU6MW-17. This, in addition to a decline in HVE contaminant removal rates suggests the HVE system is approaching design limitations and natural attenuation will be more heavily relied upon to reach cleanup goals. This indicates that concentrations of these COCs may not reach cleanup levels within the timeframe (5-years of HVE operation) that was predicted in the OU6 ROD.		
4	6	SD15	Shallow Soils. Possible migration of contaminants from soils having DRO, GRO, and BTEX concentrations exceeding ADEC ACM Level D cleanup criteria exists at two locations in relatively shallow soils above the perched aquifer. A treatability study is being implemented for the shallow soil locations to determine if the HVE system modifications will effectively treat these areas. In the interim, LUCs ensure current protectiveness.	N	Y

Section 9.0
RECOMMENDATIONS AND FOLLOW-UP ACTIONS

Recommendations and follow-up actions have been identified, as shown in Table 9-1, to address the issues presented in Section 8. The USAF will prepare separate closure documents for those treatment systems and sites that are targeted for closure.

Table 9-1

Recommendations and Follow-up Actions

Item No.	OU	Site	Recommendations/ Follow-up Actions	Party Responsible	Oversight Agency	Milestone Date	Follow-up Actions: Affects Current Protectiveness (Y/N)	Follow-up Actions: Affects Future Protectiveness (Y/N)
1	2	ST41	Surface Water: To ensure compliance of SWQC as established in the OU2 ROD, TAH and TAqH should be added to the sampling suite to ensure protectiveness of the wetlands at the point of compliance.	USAF	ADEC	2004	N	N
2	5	ST37	Additional Contaminated Seeps: Implement the plan to capture the recently discovered TCE-contaminated seeps and treat them in the existing Wetland Cell. Continue to investigate the source and extent of the Kenney Ave TCE plume upgradient of the recently discovered seeps and evaluate the potential for increases in TCE concentrations.	USAF	ADEC, EPA	2003-2004	N	Y

Table 9-1 (Continued)

Item No.	OU	Site	Recommendations/ Follow-up Actions	Party Responsible	Oversight Agency	Milestone Date	Follow-up Actions: Affects Current Protectiveness (Y/N)	Follow-up Actions: Affects Future Protectiveness (Y/N)
3	2, 4, 5, 6	ST41, SS10, FT23, SD24, SD28, SD29, ST37, SD15, LF04, WP14	Cleanup Schedules: For groundwater, conduct a thorough review of modeling results and evaluate the potential for natural attenuation to achieve cleanup levels in the timeframes specified in the RODs. Revise and/or recalibrate the models if needed. Continue groundwater monitoring according to the guidelines of the Basewide Groundwater Monitoring Program until cleanup levels are met. For OU4, continue bioventing at new site until soil cleanup levels are met. LUCs shall remain in place to ensure protectiveness.	USAF	ADEC, EPA	OU2 ST41: 2006 OU4: 2008 OU5: 2003-2004 OU6: 2004-2005	N	N
4	6	SD15	Shallow Soils. Monitor effectiveness of the recently implemented treatability study (modifications to the HVE system) and verify effectiveness of treating shallow soils at the two known areas of contamination.	USAF	ADEC, EPA	2004	N	Y

In addition to the recommendations that respond to issues cited in Section 8, several recommendations are included to optimize the remedy and/or minimize unnecessary costs. These include the following:

- In OU1, sites LF05, LF07, LF13, and OT56 have reached cleanup levels for all COCs. Based on the Decision Guide for Monitoring Well Selection and Analysis (Attachment C, Figure C-1), wells at these sites should be removed from the Basewide Groundwater Monitoring Program and the sites are recommended for closure (i.e., cleanup levels based on residential use have been achieved and no additional response actions, including land use controls are needed).
- In OU4, close the bioventing system at SD25 because soil remediation objectives have been reached and analytical data document soil contaminants are below cleanup levels that are acceptable for residential use.
- Monitor for natural attenuation of groundwater at a reduced frequency as determined by the Decision Guide for Monitoring Well Sampling Frequency (Attachment C, Figure C-2). These include:

- Discontinue monitoring for manganese at LF59 because manganese concentrations have been below the ROD-specified cleanup level for two consecutive sampling rounds in all wells monitored in OU1.
- Review and revise the frequency of sampling for some wells in OU4, OU5, and OU6 in accordance with the decision guide (USAF, 2002f). Several wells in OU4 have been shown to meet COC cleanup levels and warrant less frequent monitoring; benzene monitoring may be reduced at wells within OU5 that have historically been below cleanup levels; TCE monitoring may be reduced at OU6 wells (except at SD15) that have been below cleanup levels, and some wells associated with unstable plumes in OU5 may require more frequent monitoring.

- The OU5 ROD specified annual sediment sampling at ST37 for at least the first 5 years, and sediments have been collected in the wetland cell and Beaver Pond annually since 1997. The cleanup standard outlined in the ROD for soil was consistent with the State of Alaska cleanup levels at the time, or 1,000 mg/kg total diesel fuel hydrocarbons (TFH-diesel). None of the sediment samples have contained fuel constituents (i.e., TFH-diesel, BTEX, PAH) at concentrations above State regulatory cleanup levels. Because the soil material at ST37 has been removed, it is not necessary to continue monitoring the sediment. Sediment results collected to date are sufficient to demonstrate that significant levels of COCs are not accumulating in the sediment in the wetland cell or Beaver Pond; therefore, sediment monitoring at ST37 should be discontinued.
- A site closure report demonstrates applicable cleanup levels, acceptable for residential use, have been met by removal actions and land use controls are not needed at SA100; therefore, the USAF considers this site closed and it is not necessary to include SA100 in subsequent five-year reviews.

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Section 10.0
PROTECTIVENESS STATEMENTS

Protectiveness statements for each OU at which a remedial action has been initiated were developed in accordance with EPA guidance (EPA, 2001a) and are included in this section.

10.1 Operable Unit 1

The remedy at OU1 is expected to be protective of human health and the environment upon attainment of groundwater cleanup levels, through natural attenuation, at one remaining site (LF59). In the interim, exposure pathways that could result in unacceptable risks are being controlled.

10.2 Operable Unit 2

The remedy at OU2 is expected to be protective of human health and the environment upon attainment of groundwater cleanup levels, through natural attenuation at ST41. In the interim, exposure pathways that could result in unacceptable risks are being controlled.

10.3 Operable Unit 4

The remedy at OU4 is expected to be protective of human health and the environment upon attainment of soil cleanup levels through bioventing at two remaining sites (FT23 and SS10) and attainment of groundwater cleanup levels through natural attenuation. In the interim, exposure pathways that could result in unacceptable risks are being controlled.

10.4 Operable Unit 5

The remedy at OU5 currently protects human health and the environment in the short-term because at present, TCE has not exceeded cleanup levels at the point of compliance (i.e., Ship Creek). However, in order for the remedy to be protective in the long-term, Seeps 9, 10, and 11 must be captured and treated, and the investigation into the nature and extent of the TCE plume feeding the seeps at OU5 must be continued and evaluated to ensure long-term protectiveness.

10.5 Operable Unit 6

The remedy at LF04 North/Beach is protective of human health and the environment though the annual removal of exposed landfill debris. In the interim, exposure pathways that could result in unacceptable risks are being controlled.

The remedies at LF02, LF04 South, and WP14 are expected to be protective of human health and the environment upon attainment of groundwater cleanup goals through natural attenuation and recovery of free product (at LF04 South and WP14). In the interim, exposure pathways that could result in unacceptable risks are being controlled.

At SD15, the remedy currently protects human health and the environment in the short-term because the HVE has significantly reduced contamination and LUCs are in place to eliminate known points of exposure. However, in order for the remedy to be protective in the long-term, methods to treat the remaining areas of shallow soil contamination must be implemented or continued, as needed, following evaluation of the treatability study that is currently in progress.

10.6 SA100

The remedy (immediate response and removal actions) at SA100 is complete and protective of human health and the environment. Confirmation samples show that no contamination above background levels/regulatory cleanup levels remains and the site is acceptable for unlimited use and unrestricted exposure.

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Section 11.0
NEXT REVIEW

Future five-year reviews for OUs 1, 2, 4, 5, and 6 are necessary because contamination remains above levels that allow for unlimited use and unrestricted exposure in these areas. Future five-year reviews for SA100 are not needed because there is no evidence of contamination above levels that allow for unlimited use and unrestricted exposure in this area. The next five-year review will be completed in 2008 and no later than five years from the signature date on this document.

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Section 12.0
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